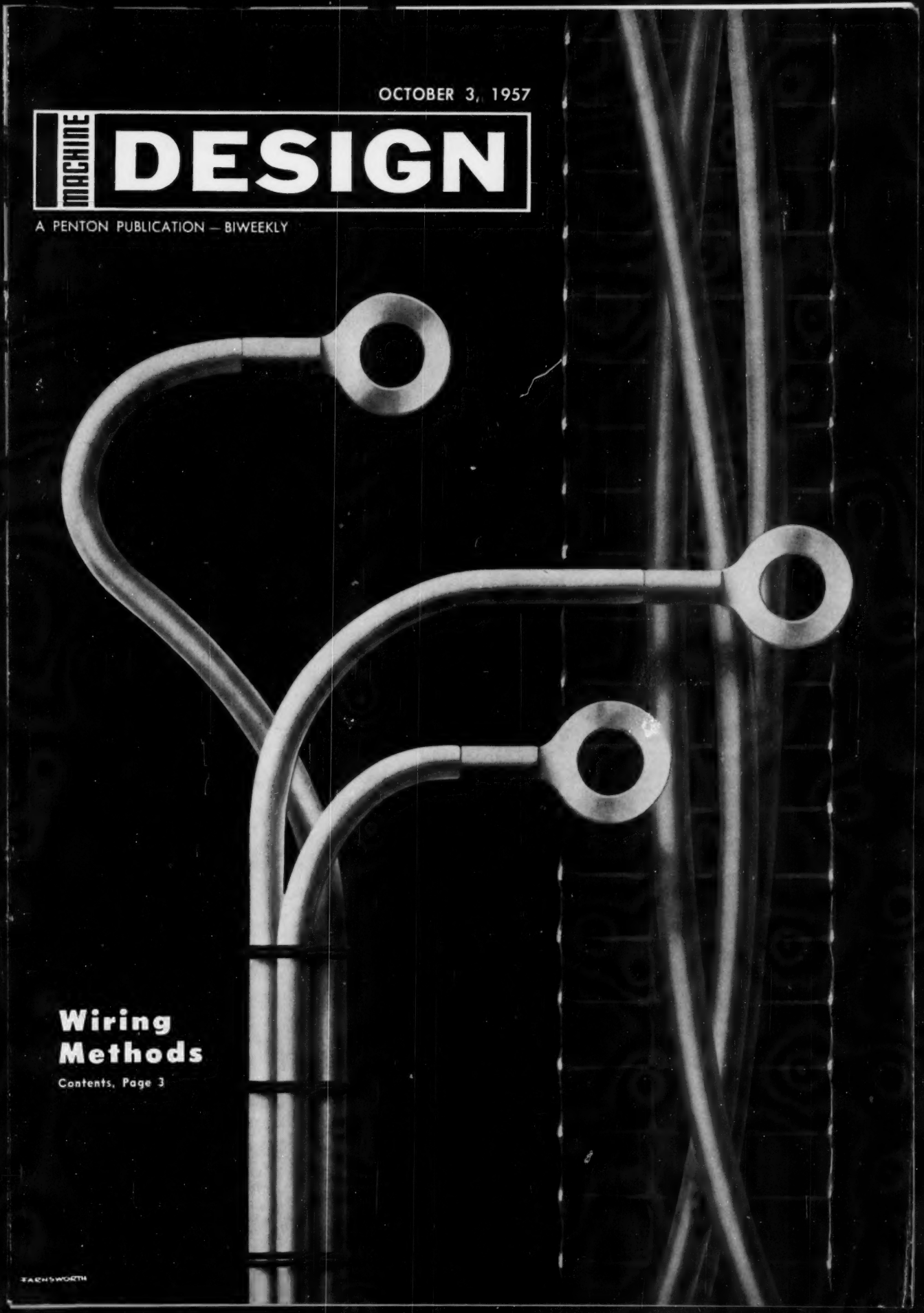
OCTOBER 3, 1957

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY



Wiring Methods

Contents, Page 3

FARNSWORTH

"Cartridge" Bearings by NORMA-HOFFMANN

Can be installed and *Forgotten!*

Norma-Hoffmann's precision-manufactured "Cartridge" bearings mean improved performance plus cost reduction — they need no attention once installed. Actual case histories tell of Norma-Hoffmann cartridge bearings installed over 15 years that are still running *without relubrication.*

"Cartridge" bearings by Norma-Hoffmann can offer you long, trouble-free life because:

* "Cartridge" bearings are adequately lubricated with exactly the right kind and right amount of grease.
* "Cartridge" bearings are fully protected with high-efficiency, all metal, non-rubbing lifetime seals.
* "Cartridge" double row width bearings are complete units ready for installing *and forgetting.*

All Norma-Hoffmann bearings are designed to improve operating efficiency and reduce costs. Get complete details now — write for descriptive literature.

precision ball, roller & thrust bearings

NORMA-HOFFMANN
BEARINGS CORPORATION • STAMFORD, CONN.
founded 1911

FIELD OFFICES: Atlanta • Chicago • Cincinnati • Cleveland Dallas • Denver • Detroit • Kansas City • Los Angeles Philadelphia • San Francisco • Seattle

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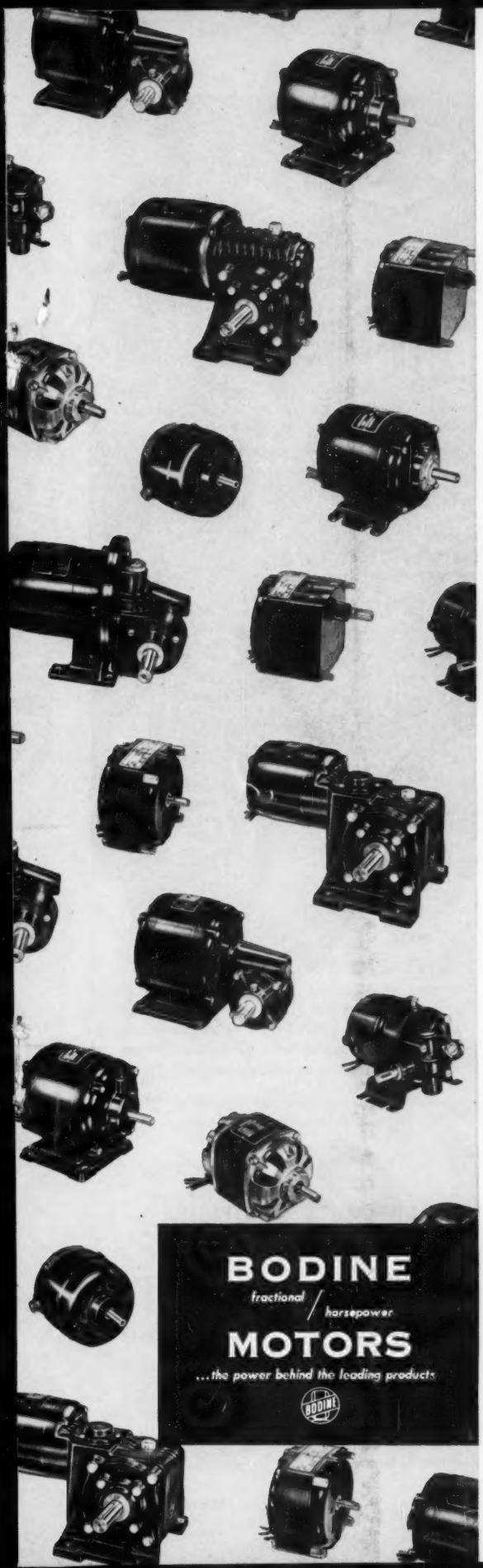


NOW!

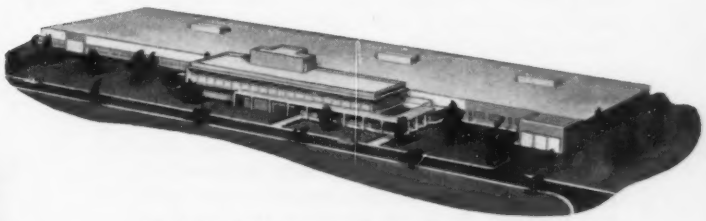
only 12 to 16 week delivery on fractional horsepower motors

Now and in the future, faster delivery . . . 12 to 16 weeks . . . on Bodine fractional horsepower motors built to order! Why? Bodine Electric Company has transferred its manufacturing operations into this spacious new plant. Vastly expanded production facilities . . . improved production methods result in much faster and more efficient production . . . without sacrificing one iota of Bodine's reputation for building *the quality* motor of the industry.

And the added production and warehousing facilities make it possible for Bodine to offer more than 265 different standard, stock types and sizes . . . ready for fast shipment.

You also get much faster delivery on your built-to-order sample test motors and reducers for prototypes . . . five to six weeks for standards . . . five to nine weeks for specials that do not require engineering or testing . . . and only eight to twelve weeks for those requiring special engineering and testing.

For more information, contact Bodine Electric Company, 2258 W. Ohio St., Chicago 12, Ill. ... or check your Sweet's Product Design File.



New Bodine Electric Company plant on Chicago's northwest side

Bodine builds fractional horsepower motors for manufacturers of: adding machines, letter openers, sanders, vending machines, exhaust fans, duplicating machines, hand dryers, portable tools, sound recorders, air conditioners, check protectors, respirators, voltage regulators, X-ray timers, traffic signal timers, stirrers, calculating machines, envelope sealers, and for many other applications.

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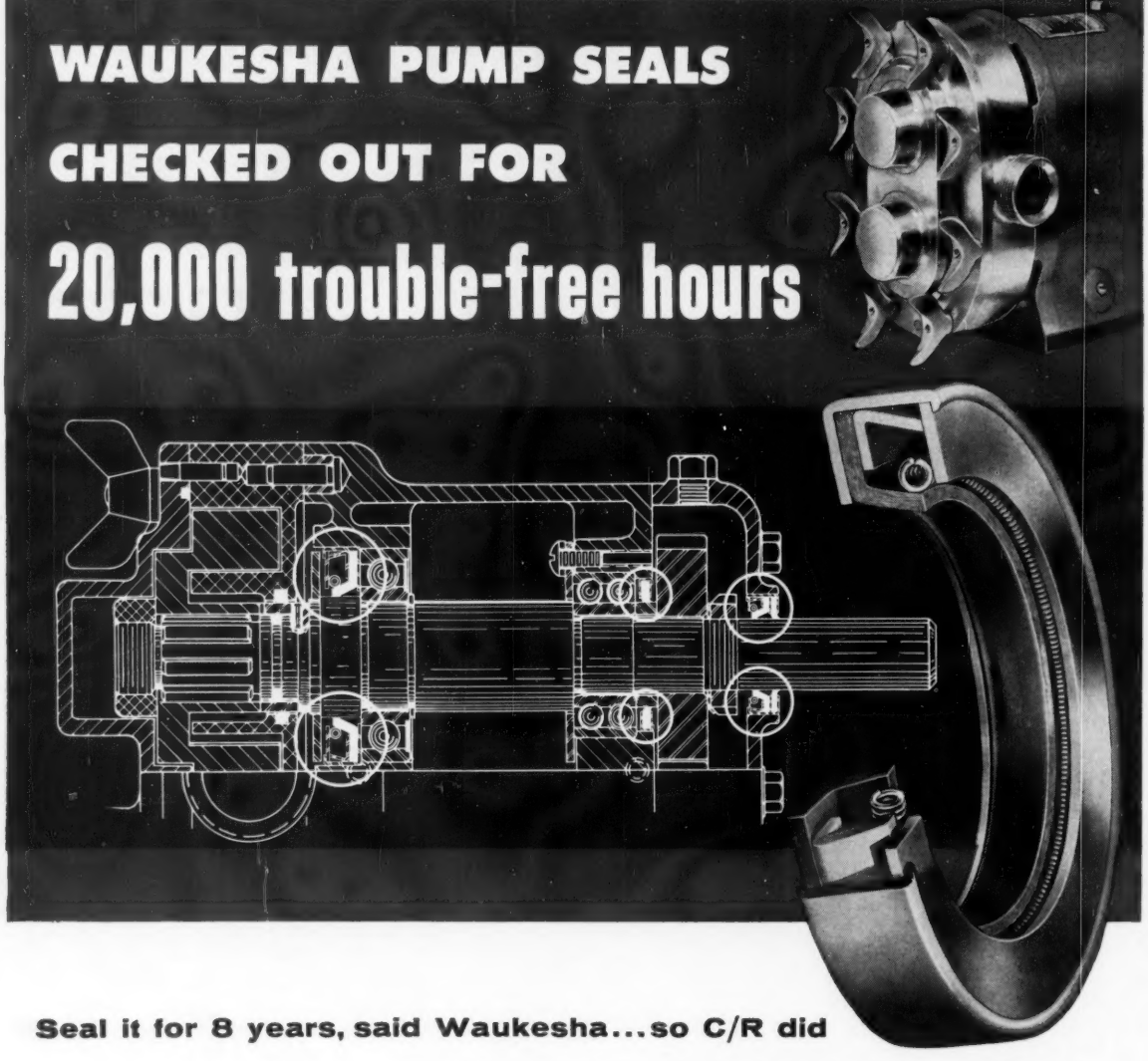
WAUKESHA PUMP SEALS CHECKED OUT FOR 20,000 trouble-free hours



Seal it for 8 years, said Waukesha...so C/R did

"And, we might add, we have had very, very few instances of failure with C/R Oil Seals," says Mr. Gilbert R. Funk, Vice President, Pump Division of the Waukesha Foundry Co. Long service life is only one of the requirements met by the C/R Types P, G and A Oil Seals in this Waukesha Sanitary Pump. They must seal effectively eight hours a day, six days a week for eight years . . . at shaft speeds up to 750 r.p.m., with pump head pressures up to 150 p.s.i., and temperatures ranging from 0° to 220° F., depending on the food material pumped. They also must resist food acids, and the acids and alkalies in the commercial detergents used to cleanse and flush the pump daily. An added indication of C/R Oil Seal dependability in the Waukesha Sanitary Pump is the fact that it constantly must meet rigid 3-A Sanitary Standards for the Dairy and Food Industries.

If you have a sealing problem . . . equally critical . . . or simple . . . bring it to Chicago Rawhide. C/R engineers will help you select the correct oil seal for your application from stock . . . or cooperate with you on special designs.

More automobiles, farm and industrial machines rely on C/R Oil Seals than on any similar sealing device.

OIL SEAL C/R DIVISION
CHICAGO RAWHIDE

CHICAGO RAWHIDE MANUFACTURING COMPANY
1221 Elston Avenue Chicago 22, Illinois

Offices in 55 principal cities. See your telephone book.

In Canada: Manufactured and Distributed by Chicago Rawhide Mfg. Co. of Canada, Ltd., Hamilton, Ontario

Export Sales: Geon International Corp., Great Neck, New York.

Other C/R Products
Sirvene (synthetic rubber) molded pliable parts • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears

Circle 405 on page 19

October 3, 1957 Volume 29—No. 20

THE PROFESSIONAL JOURNAL FOR ENGINEERS AND DESIGNERS

MACHINE DESIGN

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MACHINE DESIGN is sent at no cost to management, design and engineering personnel whose work involves design engineering of machines, appliances, electrical and mechanical equipment, in U.S. and Canadian companies employing 20 or more people. Copies are sent on the basis of one for each group of four or five readers. Consulting and industrial engineering firms, research institutions and U.S. government installations, performing design engineering of products are also eligible.

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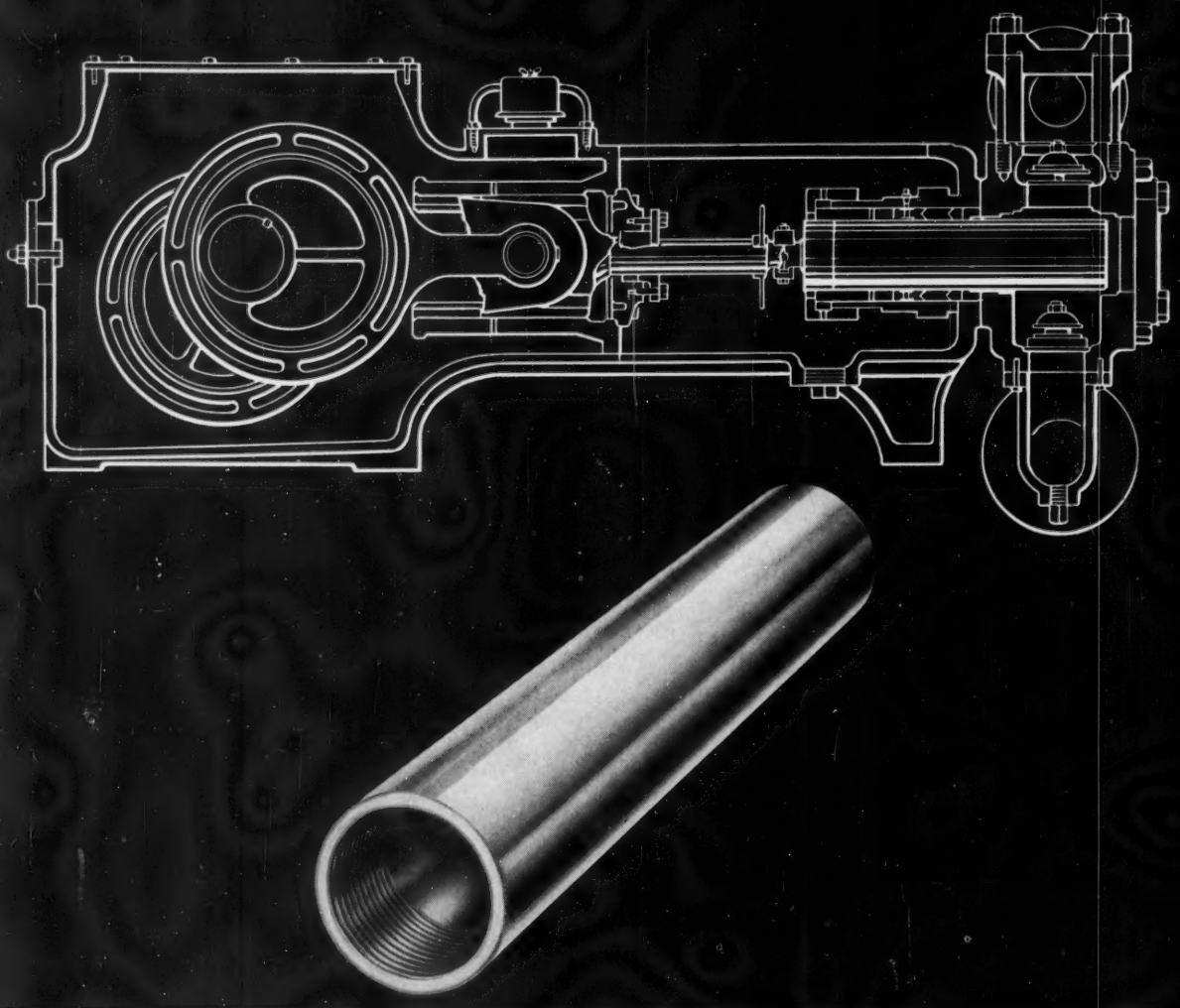


Reducing Costs With Job Matched Tubing

Does a higher grade tube really cost more? Reduced overall manufacturing cost of pump plungers resulted when one maker switched from tubing made from open hearth processed alloy steel to B&W electric-furnace Alloy Steel Tubing. Rejections on a large production run were reduced drastically (10.75% to 1.25%).

The plunger had to have a very good finish and was to be chrome plated. Jobs like this require high quality and "clean" steel. Because of B&W's melting practices and familiarity with making "clean" steels for bearings and other applications, it was suggested to the fabricator that he consider B&W electric-furnace 8620 Steel Tubing. The use of B&W electric-furnace Alloy Steel drastically reduced rejects on the finished part.

Once again Mr. Tubes proved conclusively that final cost—not initial cost—is the measure of good tube fabricating practice. If you're concerned with costs as well as producing a good finished product, get in touch with Mr. Tubes. He can help you save money. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-6100-M5

Seamless and welded tubular products, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels.

Circle 406 on page 19

Engineering News Roundup

Tube's Grid, As Shutter, Speeds Photo Exposure

Promises 10^{-8}-Sec Speed, Five Images, Increased Light

HARRISON, N. J. — Multiple-frame photography with exposures as short as one hundred millionth of a second is possible through the use of a new tube under development at the RCA Electron Tube Div.

Called an "image converter," the new tube has electrostatic focus, a grid which functions as a shutter, and a deflection system which can produce as many as five separate screen images at one time. Development of this tube was sponsored partly by the University of California under AEC contract. Many of its features embody the results of earlier research and development sponsored by the U. S. Army Engineer Research and Development Laboratories.

Light from the subject is focused on the photocathode of the tube by a fast objective lens, producing electrons which are attracted at high velocity toward the fluorescent screen at the opposite end of the converter. In their passage, the electrons first encounter a fine metal mesh called a gating grid, charged either to repel the electrons or to permit their travel toward the screen.

After the electron beam passes the gating grid, it is directed through a small aperture to a set of deflecting electrodes.

The electron beam energy is converted by the phosphor screen into actinic radiation. The screen is especially prepared with a very fine-grain phosphor and is backed with aluminum to increase light output. The tube can provide an increase in radiant energy emitted from the screen of as much as twenty-four times the radiant energy incident on the photocathode.

FIRST ROCKET-POWERED DRONE to join the service, Navy's XKDT-1, is shown here being chased by an air-to-air missile. If missile comes within a specified distance, the drone signals a "hit," remains intact to be fired upon by other weapons. The new target was designed by Temco Aircraft Corp.; is air launched, uses solid-propellant fuel. It will fly on a straight course for about 8 min, emits flares for visual tracking. Wingspan is 58 in.; length 12 ft; diameter 10 in. Ceiling is 50,000 ft; speed transonic.

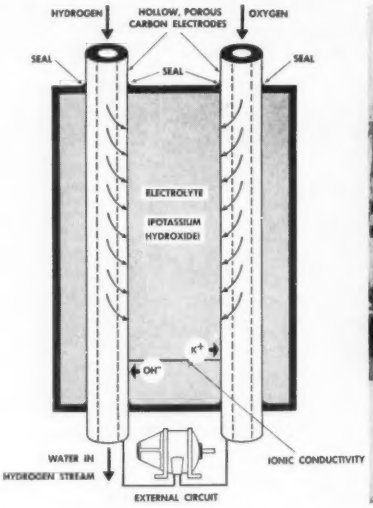
Fourth Mechanisms Conference: October 14-15

CLEVELAND, OHIO—An outstanding program is set for the Fourth Mechanisms Conference to be held Oct. 14 and 15 at Purdue University, Lafayette, Ind. Co-sponsored by MACHINE DESIGN and Purdue's School of Mechanical Engineering, the Conference is believed to be the only organized meeting of its kind devoted to methods and systems for design of mechanisms. It has enjoyed sustained interest since its inception a few years ago.

This year, 13 papers will be presented during the two-day session. Subject matter ranges from practical approaches to design and application of cams and linkages to

advanced concepts of analysis and synthesis of mechanisms. European developments will also be covered. Opportunity for informal discussion will allow Conference members to offer questions and comments on any mechanism problems.

Abstracts of each paper to be presented appeared in the September 5 issue of MACHINE DESIGN. Program details, with advance registration and room reservation forms, appear on Page 196 of this issue. For any additional information, write to Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.



Simplified fuel cell shows hydrogen and oxygen gases entering through hollow, porous carbon electrodes, diffusing through their surfaces to come in contact with electrolyte solution of potassium hydroxide. Electron flow is from hydrogen electrode through external circuit. Water formed as a by-product of the reaction passes from the cell in the hydrogen stream. Dr. Karl Kordesch, responsible for research leading to development of the fuel cell, is seen holding specially-treated electrode and examining fuel cell.

Semiprecision Molding With CO_2 Lowers Costs

Speedy Mold Hardening Requires Little Capital

CHICAGO—Combining the close tolerance of shell molding with economy of the CO_2 foundry process, a new molding process for conventional sand cores can be used with virtually all castable metals. National Cylinder Gas Co. semiprecision process uses carbon dioxide and sodium silicate-based binder to produce a chemical reaction that hardens sand molds in 15 to 30 seconds contrasted with 40 to 75 seconds for hardening a comparable shell mold.

Full scale foundry trials in Akron and Tulsa, Okla., have produced semiprecision molds equivalent to shell molding for accuracy and finish, tolerances of $\pm$ 0.002 to 0.004 in. per in. being reported.

Sodium silicate and fine sand in grain sizes from 100 to 180 AFS (American Foundry Society specifications) are mixed, then rammed into a mold pattern. Gassing with CO_2 forms a silica gel that coats the grains of sand and binds them firmly. Molds as thin as $\frac{1}{2}$ in. are practical.

Little capital investment is required to make use of the new process. Required are CO_2 gas supply, regulating equipment, gassing heads, sodium silicate binder, and inexpensive patterns.

Fuel Cell Silently Converts Gases To Big Electric Power

High Efficiency, Long Life Contribute to Potential

PARMA, OHIO—A fuel cell, through which hydrogen and oxygen gases are passed to produce thousands of watts of economical power, has been developed by National Carbon Co., Div. of Union Carbide Corp. First significant application of the cell is in providing power for the Army Signal Corps' "Silent Sentry"—world's smallest known radar set. Other applications, for the present, are limited by the cost of hydrogen.

Unlike conventional batteries, fuel cells are said to remain essentially unchanged during their operating life, and produce electrical energy from chemical fuels supplied as needed. Sample cells have been operated in a laboratory every working day for one year with no signs of deterioration. Such cycling was used for testing because repeated starts and stops are much harder on a cell than continuous operation.

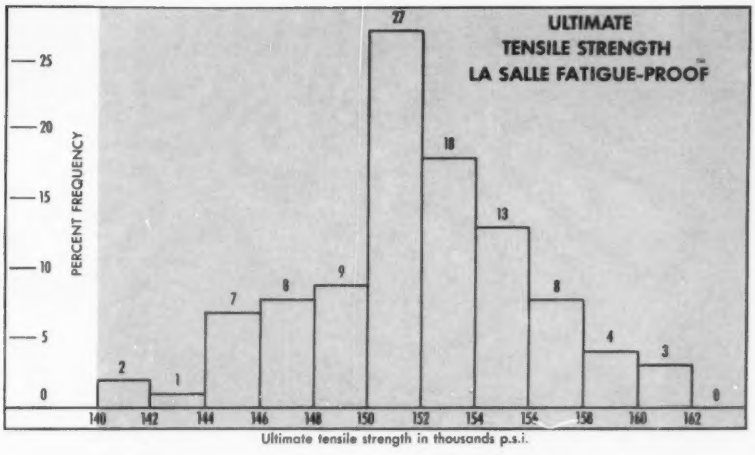
The generation of electricity directly from hydrogen and oxygen in a fuel cell is inherently more efficient than generation in a conventional steam system. Practical limitations in steam system reduce efficiency to approximately 30 or 35 per cent, while efficiency of a fuel cell, which eliminates the intermediate heat step, is said to be 65 to 80 per cent. Research and development to date indicate that the optimum fuel cell design will produce approximately 1 kw of power per cu ft of volume.

Voltage per cell is approximately 1 v. Many combinations of voltages and currents can be obtained by varying physical size of cells and connecting the cells in batteries. Basically, the fuel cell is most desirable for high-current, low-voltage use.

Inherent advantages of the cell

Front Cover

Two methods of handling wiring assemblies are shown on George Farnsworth's front cover: wiring harnesses, and channels. These and other systems are covered in J. W. Keller's article on Page 121.



The above chart shows the range of ultimate tensile strength over a period of one year's production. Average value obtained is approximately 150,000 p.s.i.

"e.t.d."™ Process Applied to FATIGUE-PROOF™ Steel Bars Gives Added Strength, Greater Uniformity, Better Machinability

Guaranteed 140,000 p.s.i. minimum tensile... no heat treating necessary

Six important physical and mechanical properties, (1) a high strength level, (2) exceptional uniformity, (3) improved machinability, (4) wear resistance, (5) resistance to fatigue, and (6) dimensional stability, are desirable features of La Salle "FATIGUE-PROOF" steel bars, produced by the new "e.t.d." (Elevated Temperature Drawing) process.

Strength . . . "FATIGUE-PROOF" is a carbon steel bar which replaces both hot-rolled or cold-finished carbon and alloy heat-treatable steel bars. Production figures show hardnesses between Rc 30 and Rc 36 (with a minimum hardness guarantee of Rc 30). The guaranteed minimum tensile strength is 140,000 p.s.i. with a 150,000 p.s.i. average.

"FATIGUE-PROOF" is better than a heat treated bar because it is not quenched and tempered and so the problems frequently associated with quenching and tempering such as (1) quench cracks, (2) non-uniformity of section, (3) soft centers, and (4) heat treat distortion are eliminated. Costly secondary operations such as grinding, cleaning, and straightening are not necessary. Rejects are minimized.

Exceptional uniformity... "FATIGUE-PROOF" is remarkably uniform from bar to bar, end to end, size to size, and lot to lot. Design and production engineers can depend upon it being the same from day to day and job to job.

Individual processing of each bar plus the inherent good qualities and characteristics of the "e.t.d." process account for the excellent uniformity. Microstructures are uniformly pearlitic.

Improved machinability... "FATIGUE-PROOF", made by "e.t.d.", machines 50% to 100% faster than heat treated alloys, and 25% faster than annealed alloy steels. It machines with a very fine finish, and gives excellent tool life. These characteristics make it an ideal steel for production parts.

Wearability . . . Field applications such as gears, pinions, pins, and screws prove that "FATIGUE-PROOF" has good wear resistance. It resists galling and seizure, partly due to its hardness . . . and probably due to the anti-weld characteristics of its chemistry. Further, "FATIGUE-PROOF's" pearlitic structure appears to resist sliding wear better than a quenched and tempered structure of equal hardness.

Resistance to fatigue . . . The chief reason for the failure of highly stressed parts is fatigue. While part shape, unfavorable residual stresses, tool marks, gouges in highly stressed areas, and many other factors contribute to fatigue failure, most materials have also an inherent quality . . . endurance limit that is an indication of ability to resist fatigue.

"FATIGUE-PROOF" has this inherent quality to resist fatigue. Laboratory tests prove that fatigue properties are at least comparable to those of expensive heat treated steels of the same strength level. Numerous field tests, under severe operating conditions, have proved this to the satisfaction of many manufacturers.

Dimensional stability... "FATIGUE-PROOF" maintains a high degree of dimensional stability in machining because of its low order of residual stresses.

Details of the e.t.d." process . . . Elevated Temperature Drawing involves (1) the selection of bar chemistry, (2) the amount of reduction in cross-sectional area of the bar as it is drawn through a special die, and (3) a preselected elevated drawing temperature which will result in the desired final properties.

Although the "e.t.d." process was first announced early in 1957, it has been used in the production of "FATIGUE-PROOF" steel bars since September 1955. Four U.S. Patents (Nos. 2,767,835, -6, -7, and -8) were granted October 23, 1956, covering the "e.t.d." process – an exclusive development of La Salle Steel Company.

How manufacturers can obtain sample Fatigue-Proof steel bars for testing

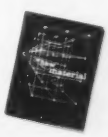
LaSalle Steel Company has announced that samples of "FATIGUE-PROOF" steel bars, made by the "e.t.d." (Elevated Temperature Drawing) process, are available for test purposes on a no charge basis to manufacturers where it appears that "FATIGUE-PROOF" can help improve products and reduce production costs.

Applications for a sample bar are invited from manufacturers making parts from either hot-rolled or cold-finished carbon or alloy steel bars which require high tensile strength.

Interested manufacturers may write for a test sample by sending a blueprint or application details direct to LaSalle Steel Company, Advertising Department, P. O. Box 6800-A, Chicago 80, Ill.

"FATIGUE-PROOF" is also available from your steel distributor . . . write for his name.

Brochure tells story of Fatigue-Proof steel bars



"A New Material" is the title of a 24-page booklet which gives detailed information covering La Salle "FATIGUE-PROOF" steel bars made by the Elevated Temperature Drawing process.

The booklet presents the results of more than one year's tests of production samples and reports on eight application case studies. Copies available on request.

TM—Trademarks of La Salle Steel Company

ROBOT TRACTOR pulls two trailers, 4000-lb paper load, up 8.5 per cent ramp. Powered by 24-v battery, trailer stops automatically at loading, unloading stations. Guide-O-Matic tractor, product of Barrett-Cravens Co., is controlled by radio signals and guide wire buried beneath surface of route. "Sniffer" box picks up commands instantly, causes tractor to follow route of guide wire to destination. Tractor will stop if it leaves path; retrace accuracy is plus or minus ½ in. Here it runs from warehouse to shipping dept.

make it an excellent source of silent electrical power in remote locations where conventional fuels or water power are not available. Military communications systems, mobile power units, and standby power plants are a few expected applications.

Buick Plans New Entry In Luxury Car Market

FLINT, MICH. — Top series in Buick's 1958 line will be the Limited. The new series was a regular member of the Buick family before World War II, but was discontinued at the end of 1942.

The Limited, along with all other cars in the Buick line, was shown at a recent press preview. Although details were withheld until Oct. 22, Buick officials said the 1958 models would feature completely new styling, including a grille design "unlike anything ever seen in the industry before." A new triple-turbine dynaflow and air ride will be available on all models.

Amplitron Tube To Multiply Strength of Radar Signals

More Capacity in Less Space Seen Boon to Aircraft

WASHINGTON—Lighter, more compact, more versatile radar sets are now made possible by a new electron tube that doubles the efficiency of existing radar boosters. Known as the "amplitron," the new tube was developed by the Army Signal Engineering Laboratories and Raytheon Mfg. Co.

The amplitron works on the same principles as ordinary TV and radio tubes, but it looks different. It is enclosed in a disc-shaped metal case with power connections projecting from its edges. At 10 lb, it is considered light for its capacity.

The amplitron can boost the energy output of a basic radar signal as much as 8 to 14 times. It enables rapid tuning to evade enemy jamming or interference.

As a secondary function, the amplitron can be a generator of basic radar waves. Used thus, its

Topics

Southern vacation idea: First commercial flight from the United States to the Antarctic leaves San Francisco October 12. Besides transporting people and freight, the flight will serve to demonstrate the "feasibility of commercial air operations to the only remaining continental frontier."

• • •

Other travel news indicates that it may be Ladies First on trips to the moon. The American Psychological Association has ventured to guess that the moon's first visitor may be a woman, basing its opinion on the physical demands of rocket travel.

• • •

First lake tanker built for service in the St. Lawrence Seaway was launched recently. The *Imperial Queen* is 375 ft long and can carry 6000 tons.

• • •

Gas-turbine engines may soon replace diesel power in small boats. Recent 1500-hr trials of two 500-hp engines on Navy minesweepers were carried out without failure of any of the high-speed rotating parts.

• • •

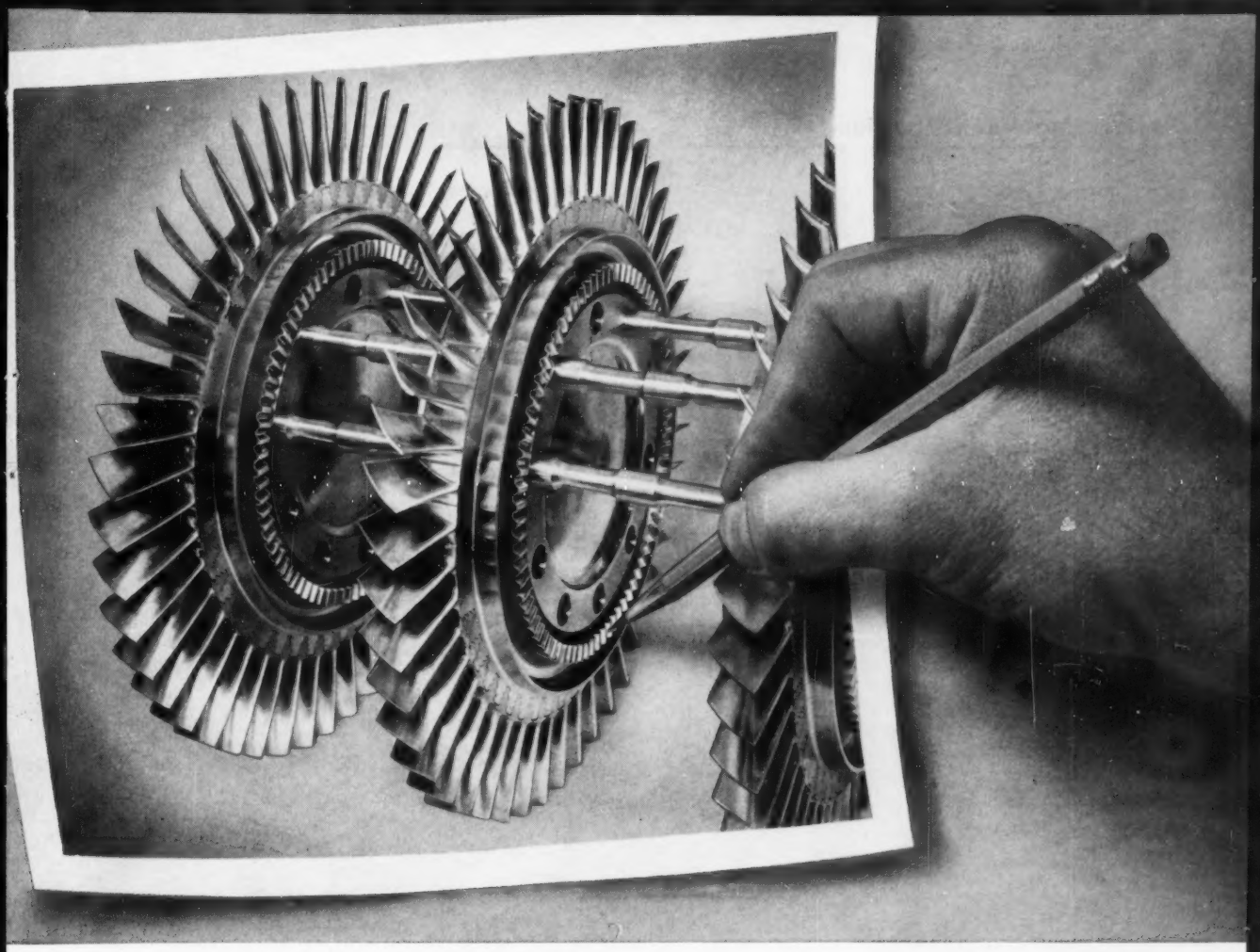
In-flight refueling—of pilots—posed a problem on long-range, high-altitude jet flights, since removing an oxygen mask long enough to eat or drink is impossible. Solution of the problem is in 2-qt thermos bottles and lengths of plastic surgical tubing, through which the flyer drinks his meal.

• • •

Navy discovers the moon can be used as a radio relay station. This is the conclusion of Naval scientists after six years of experiments, conducted with six different radar nets at the Naval Research Laboratory in Washington.

• • •

Around the world in a daze—brought on by traveling faster than the earth moves around the sun—could result from flying on the 2000-mph commercial airliners predicted by both Boeing and Lockheed by the year 1970. Passing through time zones at this clip might confuse a person's eating pattern, for he would leave London at lunch time and be in New York in time for breakfast.



Can CURVIC® Couplings lower the cost of your product?

They have done so for scores of manufacturers, by reducing machining time, by saving time in assembly and by permitting more compact design.

CURVIC Couplings are extremely accurate toothed connections which combine the functions of driving, centering and alignment.

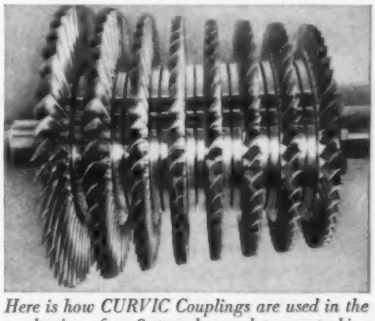
With CURVIC Couplings, complex machine parts can be made in several smaller units and then bolted or otherwise fastened together. Experience has proved that fabrication of many large parts in smaller units has reduced the time spent in machining, simplified final assembly, and reduced over-all manufacturing costs.

And there is no sacrifice of precision —in fact, CURVIC Couplings are so accurate that tolerances in the finished assembly can be held closer than when the part is made by any other means.

CURVIC Couplings are used in such applications as heavy-duty gas turbine rotors like the one shown above, jet engines, crankshafts and camshafts.

In addition to fixed or permanent connections, CURVIC Couplings can be produced in semiuniversal, and in releasing clutch types.

All types of CURVIC Couplings are produced rapidly, economically, and with high precision, on Gleason Cutting and Grinding Machines. If you would like to know more about CURVIC Coupling design or manufacture, the Gleason Works will be glad to consult with you, and to make recommendations about your specific applications. Write for our booklet.



Here is how CURVIC Couplings are used in the production of an 8-stage heavy-duty gas turbine rotor, holding it in perfect alignment under the severe stresses encountered at high speed.

GLEASON WORKS

Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N. Y.

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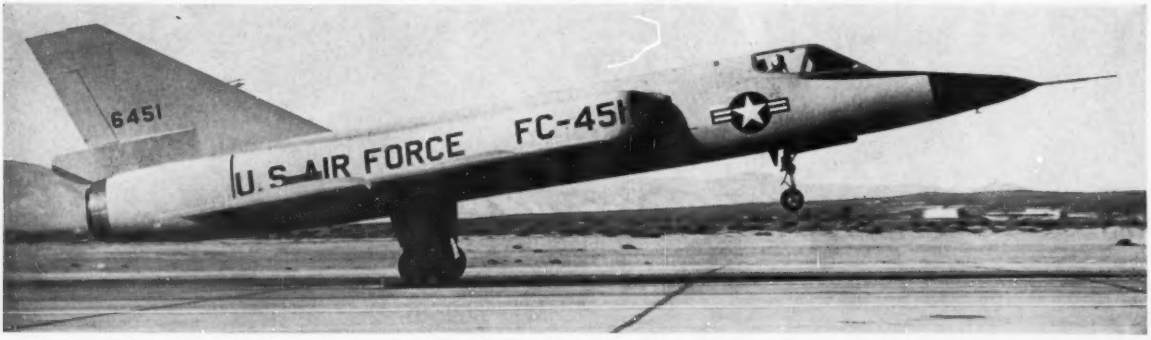
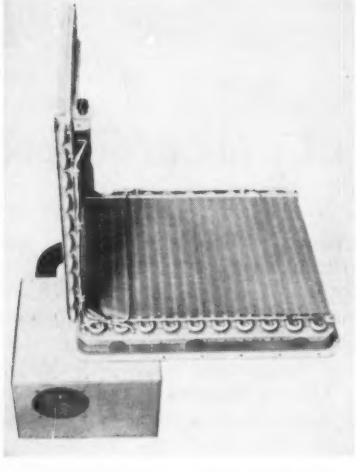
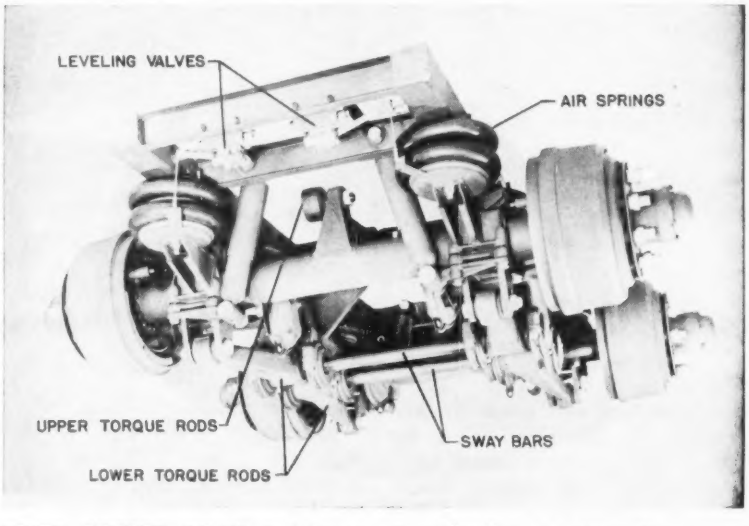


FASTEST ALL-WEATHER INTERCEPTOR ever flown, Convair's F-106A Delta Dart is shown undergoing recent flight tests. The new plane is equipped with the most advanced fire-control system and armament of any Air Force interceptor. Fuselage is more than 70 ft long. Swept-back vertical stabilizer stands 20 ft above ground level. Like all true Deltas, the F-106A has no horizontal stabilizer. Control is achieved through "elevon" surfaces on trailing edge of the wing. Clamshell dive brakes are located at base of the vertical stabilizer. A two-place version of the new interceptor is also under development at Convair. It differs externally from the F-106A only in the forward section of the fuselage, which will provide two tandem cockpits.

signal is ten times steadier than the output of present high-power magnetrons.



COLD BEER AT ALTITUDE could be stored with airborne refrigeration system designed for operation from sea level to 25,000 ft, ambient temperatures 0 to 110 F. Eastern Industries, Inc., saves weight in new food storage system by specifically designing box temperature control unit, economizer, condenser, evaporator, filter-dryer, and expansion valve for aircraft use, rather than merely cutting out components. Unit will withstand shock and vibration in accordance with MIL-E-5272A, Procedure 1. Uses 400-cycle motor.



LEVEL UNDER LOAD is keynote of semitrailer air suspension system featuring integrated air reservoirs and advanced sway control designs. Automotive Div. engineers of the Clark Equipment Co. claim that trailer bed remains level both laterally and vertically under all load conditions. Air from the tractor's compressor is fed by a common line to each reservoir. In turn, each reservoir serves one side of the air suspension independently of the other. Ratings for single axle models are 18,000 to 20,000 lb; 32,000 to 36,000 for tandem. Complete assemblies include frame, reservoirs, shock absorbers and filters for simple installation on new equipment.

New Synthetic Rubber Resists Ozone, Oil, Heat, Cold

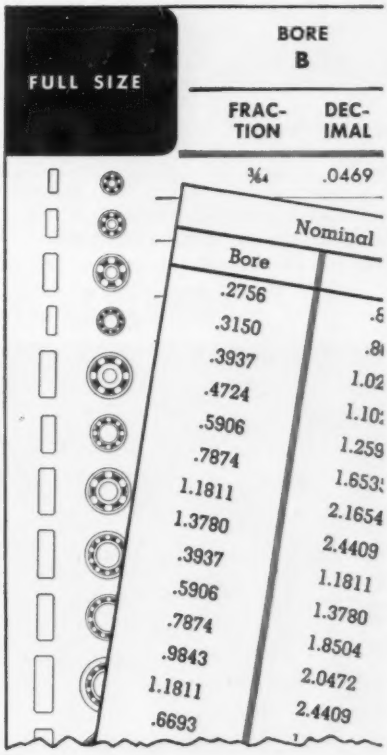
AKRON, OHIO—A new synthetic rubber developed by General Tire & Rubber Co. is claimed to be completely oil and ozone resistant and can be stored indefinitely without deteriorating. Called Genthane "S," the new product is a polyurethane that can be processed on standard rubber machinery and adheres well to synthetic fibers and metals.

Immediate applications will be in

ND FACTS

BALL BEARINGS FOR GIANT JETS OR TINY INSTRUMENTS

From high-capacity mainshaft turbine bearings of special steels and finish, stabilized for high temperature operation, down to tiny precision instrument bearings of exquisite accuracy—look to New Departure as the source you can rely on. For New Departure has the experience, the equipment and the ability to produce the world's finest ball bearings.



Turbine bearings with two-piece inner rings in bore sizes from 25 to 220 millimeters. Send for New Departure catalog ABC.

Precision instrument bearings in bore sizes from 3/64 to 3/8 inch. Send for catalog PIB.

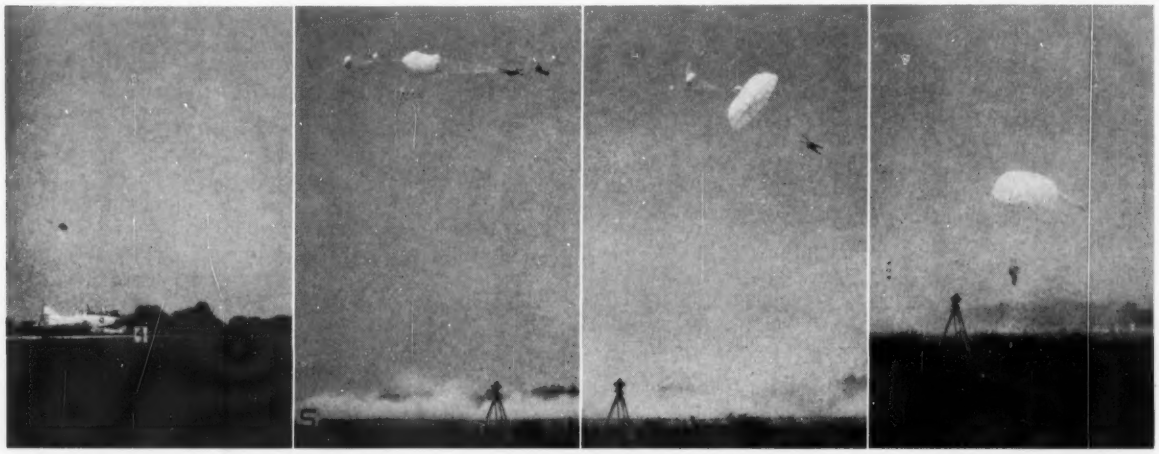
NEW DEPARTURE
DIVISION OF GENERAL MOTORS, BRISTOL, CONN.
NOTHING ROLLS LIKE A BALL

Circle 409 on page 19

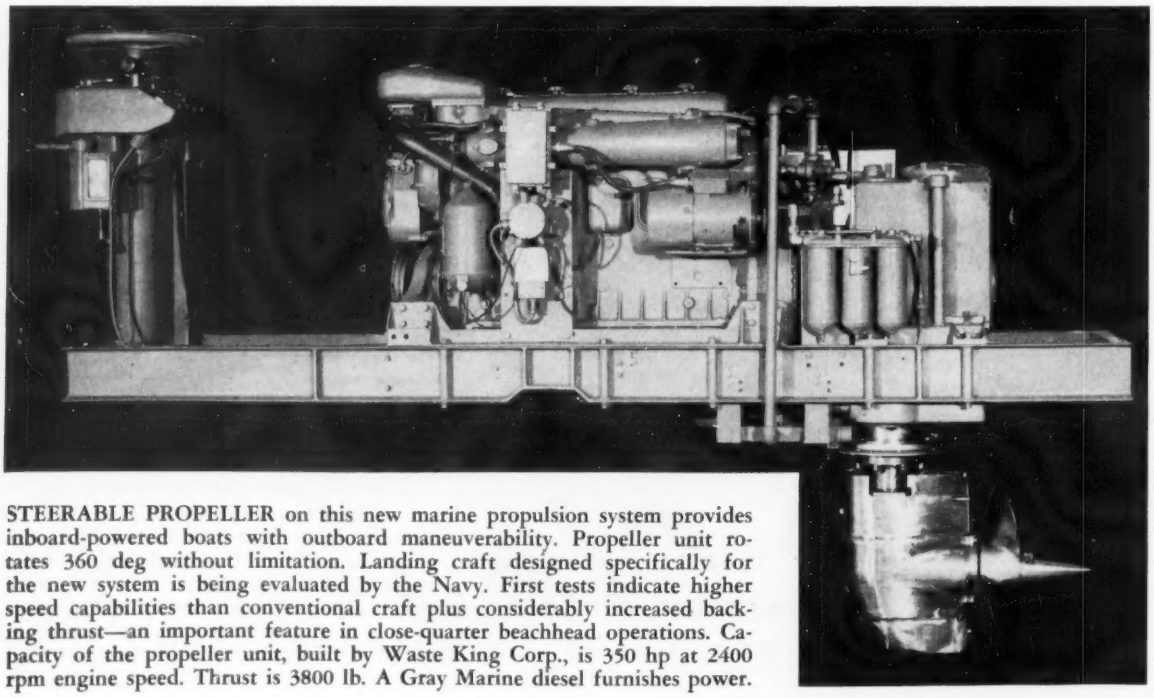
valves, gaskets, oil hoses, O-rings, oil seals, wire and cable insulation, and various similar products. Its suitability for tire applications is being studied.

According to General Tire officials, Genthane shows unusual high-temperature stability and low-temperature flexibility. It is relatively unaffected by ultraviolet rays, remains rubbery at −40 F, does not become brittle at −100 F, and will not crystallize. It has good abrasion resistance and resilience.

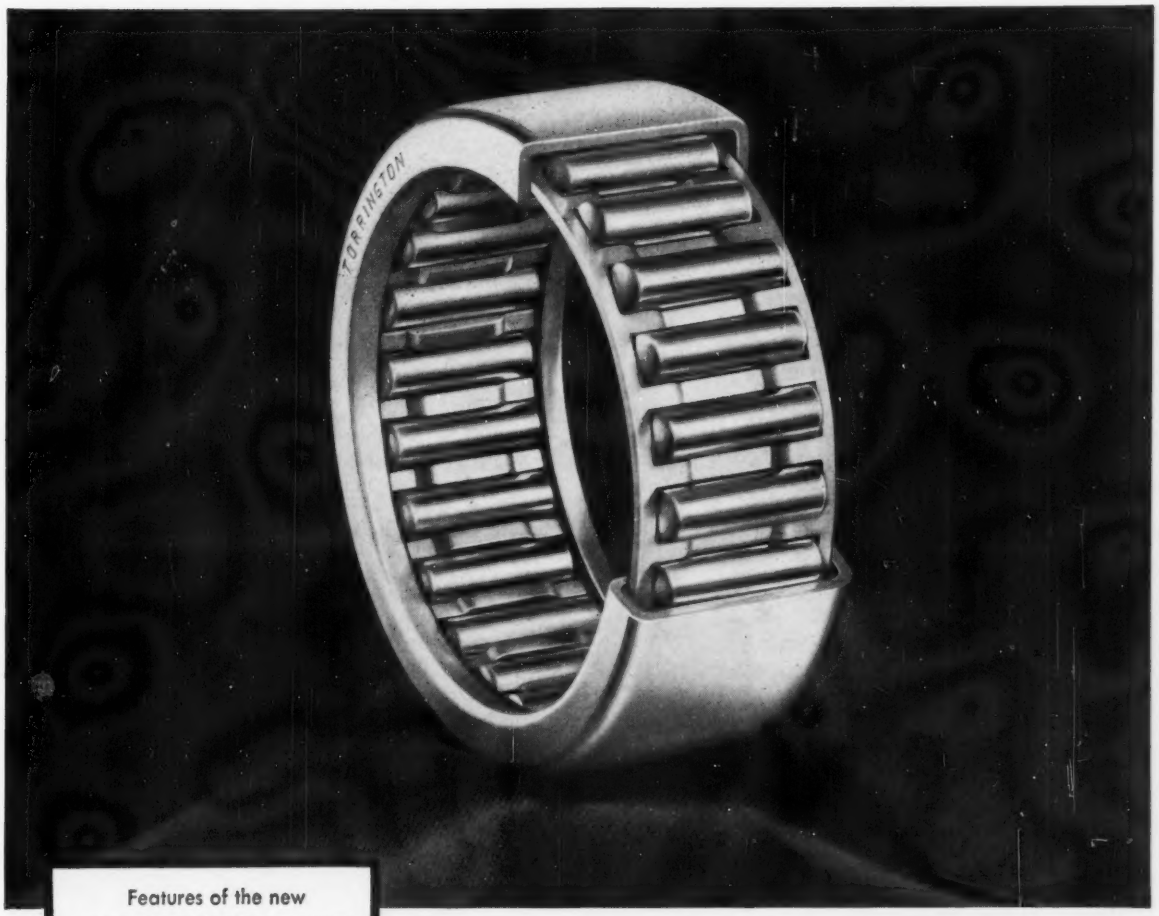
In production, the new synthetic can be used with low-cost fillers such as carbon black, silica, and clay.



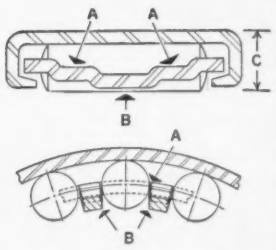
BAILING OUT AT GROUND LEVEL was demonstrated recently in the U. S. for the first time. Navy and Grumman Aircraft Corp. conducted the test with a British subject and a new British ejection seat developed by Martin-Baker Aircraft Co. of England. In sequence above, a two-place Navy jet was traveling at 120 knots several feet above ground when ejection was activated. Subject was fired high enough into the air to provide time for three stages of parachutes to open. Time lapse from plane to ground: 5 sec. Based on statistics which show two-thirds of all jet fatalities to occur on take-off or landing, Navy figures the new seat will save lives of 277 Naval pilots during the next year. Other military branches may adopt the seat.



STEERABLE PROPELLER on this new marine propulsion system provides inboard-powered boats with outboard maneuverability. Propeller unit rotates 360 deg without limitation. Landing craft designed specifically for the new system is being evaluated by the Navy. First tests indicate higher speed capabilities than conventional craft plus considerably increased backing thrust—an important feature in close-quarter beachhead operations. Capacity of the propeller unit, built by Waste King Corp., is 350 hp at 2400 rpm engine speed. Thrust is 3800 lb. A Gray Marine diesel furnishes power.



Features of the new
TORRINGTON DRAWN CUP ROLLER BEARING



- rollers end-guided at pitch line (A)
- shaft-riding retainer (B) designed to permit lubricant circulation
- high capacity in small cross section (C)
- long pregreased life
- efficient at high speeds
- mounted by press fit
- simple housing design
- low unit cost

INTRODUCING

a new low-cost precision roller bearing...

THE TORRINGTON DRAWN CUP ROLLER BEARING

For the first time, the advantages of drawn cup outer race construction are available in a precision roller bearing.

This compact, lightweight bearing consists of spherical end needle rollers, a one-piece hardened steel retainer and case-hardened thin-section outer race. Designed to run on a hardened shaft or with an inner race, this new series takes a press fit in a simple housing without snap-rings or shoulders.

Highly efficient roller guidance and lubrication are outstanding features. The shaft-riding retainer contacts the roller ends at the pitch line where guidance can be obtained with the least effort. The design provides ample storage for lubricant and promotes its circulation.

These features make the new bearing particularly suited to applications requiring compactness with precision, high-speed endurance or long pregreased life.

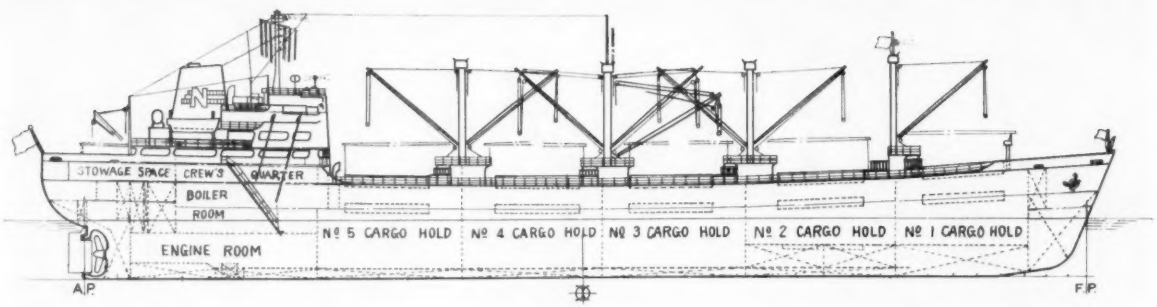
For information on sizes now available and for application assistance, call on our Engineering Department or write for the new bulletin, "Torrington Drawn Cup Roller Bearings." THE TORRINGTON COMPANY, Torrington, Conn. — and South Bend, Ind.

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • THRUST • BALL • NEEDLE ROLLERS

Circle 410 on page 19



CONCENTRATED AFT, the machinery, navigating bridge, and living spaces for officers and crew, in a single group, distinguish *World Japonica*—first-of-type, general-purpose cargo ship for the Niarchos Group. Built at Hiroshima, Japan, the ship is 504 ft long, has 67-ft beam and 30-ft draft. Cargo rating of 15,000 tons, 1500 more than American Mariner type, puts *World Japonica* in big-ship class. Steam turbine of 7150 shp gives the ship 17-knot speed. Superstructure arrangement, unusual in ships this size, permits efficient use of midships spaces for cargo and simplifies location and use of cargo handling gear, transport of bulk cargoes.

Dip-Applied Thin Gold Coats May Rival Electroplate

Printed Circuit Applications Seen

CLEVELAND—On many metals, 24-carat gold coatings imparted by a new dipping process are claimed to be superior to coatings of the same metal obtained by electroplating. Called Atomex, the dipping process has been announced by Baker & Co. Inc.

The new process requires no current or special equipment. Objects to be coated are simply immersed in a bath. Atomex works by ionic displacement. Attacked chemically, the base-metal surface sheds atoms into the bath. These are replaced by atoms of gold from the bath.

Coatings up to 0.00001 in. thick can be applied to most metals. The rate of deposition varies with the type of metal being plated and the bath temperature. It takes about 3 minutes at 60 C to deposit 1 mg/sq in. on iron, die-cast metals, steel, or soft solder. At 90 C, it takes 1½ minutes.

Advantages claimed for the process over electroplating are:

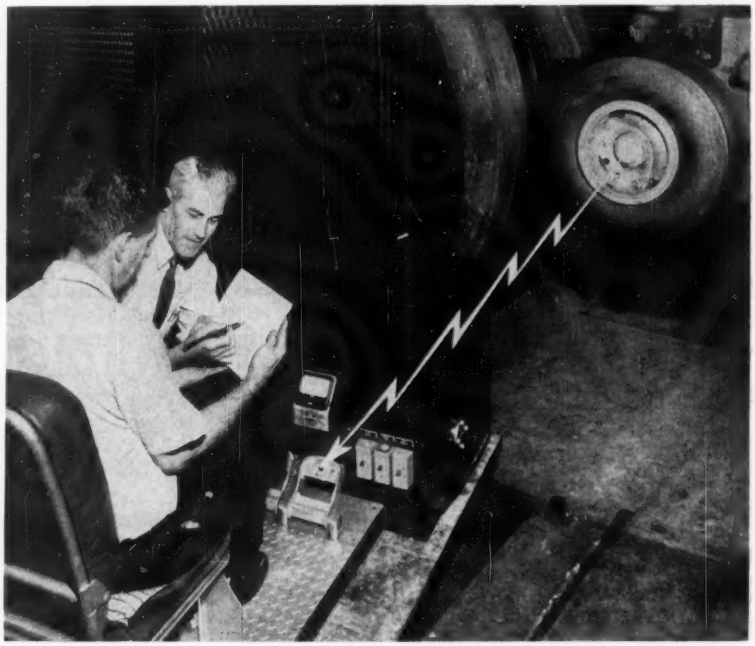
1. The coating is denser, so that the same properties can be achieved with 35 per cent less gold.

2. Since there is no electrical shielding, there are no low or high-density areas. All parts of the object, even blind recesses and the inside of tubing, receive a uniform deposit.

3. The gold actually interlocks with the base metal, providing a much firmer bond.

4. Analytical control of the bath is unnecessary because there is no free cyanide or carbonate buildup.

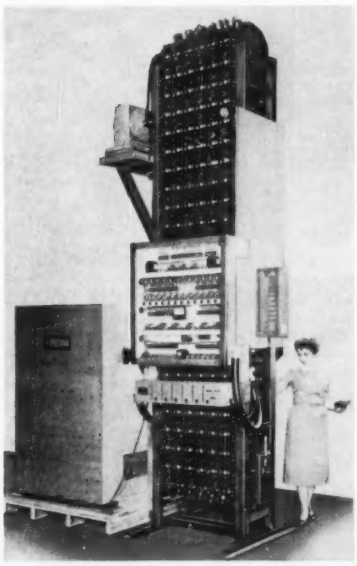
5. All the gold in the bath can be used. The spent solution is thrown



PEDAL PUSHES PILOT in this system which warns of an impending skid; Goodyear Aviation Products engineers are shown checking dynamometer test results. Once warned, pilot can ease off on brake pedal to avert skid. Sensing device is small dc generator in axle bore transmitting voltage in direct proportion to wheel speed. Control box in plane interprets voltage and causes plunger, mounted underside the brake pedal, to thump pilot's foot. Extensive tests revealed system's capability for shortening stopping distances as well as ability to warn of impending skids. Trials included 32 test stops made at speeds up to 198 miles per hour on loose rock and sand.

away.

6. Printed circuits can be coated after etching, since electrical connections are not required.



AUTOMATIC MOTOR TESTER provides a 15-minute run-in period for electric motors at the rate of 1000 motors per hour. Specific tests disclose grounds, open circuits, and shorts. Tester can be changed to process more motors per hour, and to test ac or dc and reversible types. Named Lectrotest, the machine is made by Michigan Production Engineering Co., Hazel Park, Michigan.

L. A. Motorists Must Tolerate Smog Their Cars Make

Alternatives Are Low Engine Performance, Old Carburetors

NEW YORK—Smog-bound California motorists will find themselves on the horns of a dilemma as a result of investigations reported recently by George J. Nebel and M. W. Jackson of General Motors Research Staff. Oxides of nitrogen originating in auto exhaust are heavy contributors to Los Angeles smog, but engine performance must be sacrificed if output of the oxides is reduced.

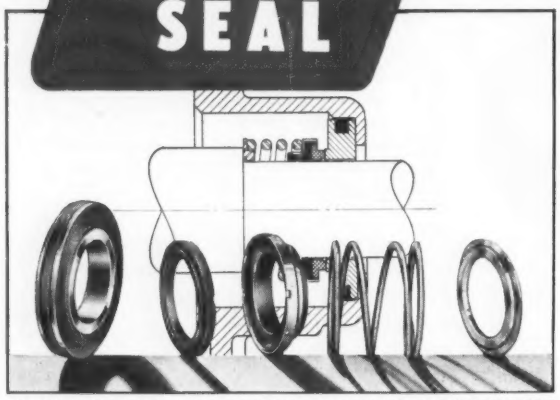
The GM study had involved tests

(*Please turn to Page 22*)

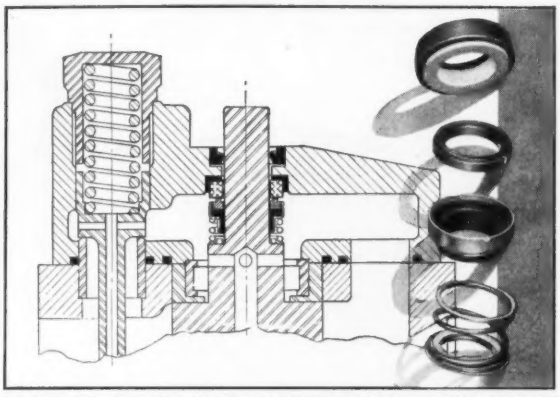
Circle 411 on page 19

ROTARY SEAL

SPECIALIZED SEAL ENGINEERING

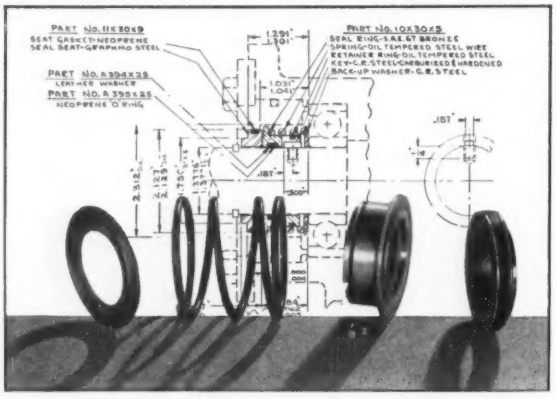


COMMERCIAL AIR CONDITIONING EQUIPMENT

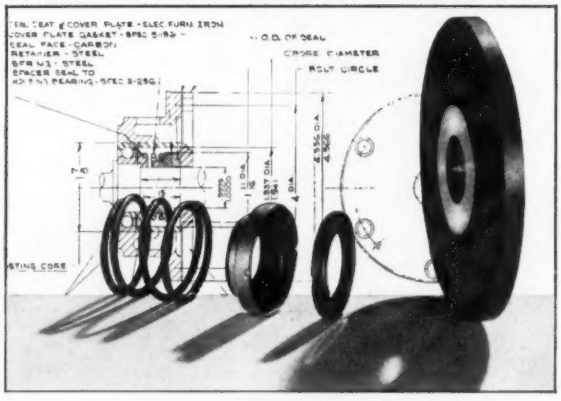


TRACTOR HYDRAULIC DIRECTIONAL FLOW VALVE

HIGH-PRESSURE HYDRAULIC OIL PUMPS



AUTOMOBILE AIR CONDITIONING COMPRESSORS

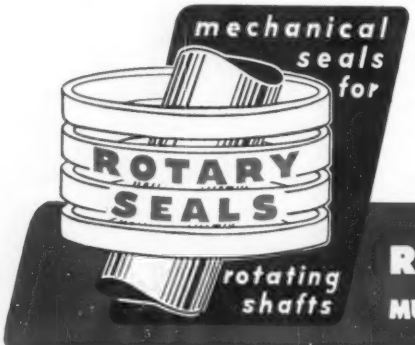


These ROTARY SEALS are "*tailor-made*" to solve specific problems

No off-the-shelf stop-gaps or compromises here—these Shaft-Sealing problems are tough, and it took specialized development to come up with precisely the *right* Seal to meet all the conditions successfully in each case.

It takes experience plus painstaking and ingenious engineering to produce these right answers, too—the kind of experience that only years of specialization can provide. Since the introduction of the basic ROTARY SEAL principle years ago, we have met and overcome the challenge of hundreds of tough assignments like those illustrated, for leading manufacturers in every field.

If you manufacture HYDRAULIC DEVICES—APPLIANCES—GEAR BOXES—AGRICULTURAL EQUIPMENT—PUMPS—AIR CONDITIONING—or any other line where secure Shaft-Sealing *must* be a certainty, call in the ROTARY SEAL experts, preferably at the drawing board stage. With our expanded sales engineering and production facilities, it's ten to one we can "tailor-make" exactly the right Seal to do *your* job.



Shaft-Sealing with Certainty

ROTARY SEAL DIVISION

MUSKEGON PISTON RING CO., SPARTA, MICHIGAN

Circle 412 on page 19

Reader Information Service

SUBJECT INDEX

Editorial and Advertising content classified by subject and listed by page number for convenience when studying specific design problems. For further information on subjects advertised, refer to advertisement and circle Item Number on a Yellow Card—following page.

MACHINE DESIGN is indexed in Industrial Arts and Engineering Index Service, both available in libraries, generally

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CIRCLE ITEM NUMBERS—Throughout the magazine, each advertisement carries an Item Number for use in requesting further information. All product descriptions, announcements and Helpful Literature items are also numbered, and for greater convenience are indexed below by Item Numbers.

EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

Index to New Parts & Helpful Literature
BY ITEM NUMBERS

HELPFUL LITERATURE— descriptions start on page 146

NEW PARTS & ENGINEERING EQUIPMENT— descriptions start on page 158

MACHINE DESIGN
Oct. 3, 1957

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401	426	451	476	501	526	551	576	601	626	651	676	701	726	751
402	427	452	477	502	527	552	577	602	627	652	677	702	727	752
403	428	453	478	503	528	553	578	603	628	653	678	703	728	753
404	429	454	479	504	529	554	579	604	629	654	679	704	729	754
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421	446	471	496	521	546	571	596	621	646	671	696	721	746	771
422	447	472	497	522	547	572	597	622	647	672	697	722	747	772
423	448	473	498	523	548	573	598	623	648	673	698	723	748	773
424	449	474	499	524	549	574	599	624	649	674	699	724	749	774
425	450	475	500	525	550	575	600	625	650	675	700	725	750	775

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Cleveland 13, Ohio

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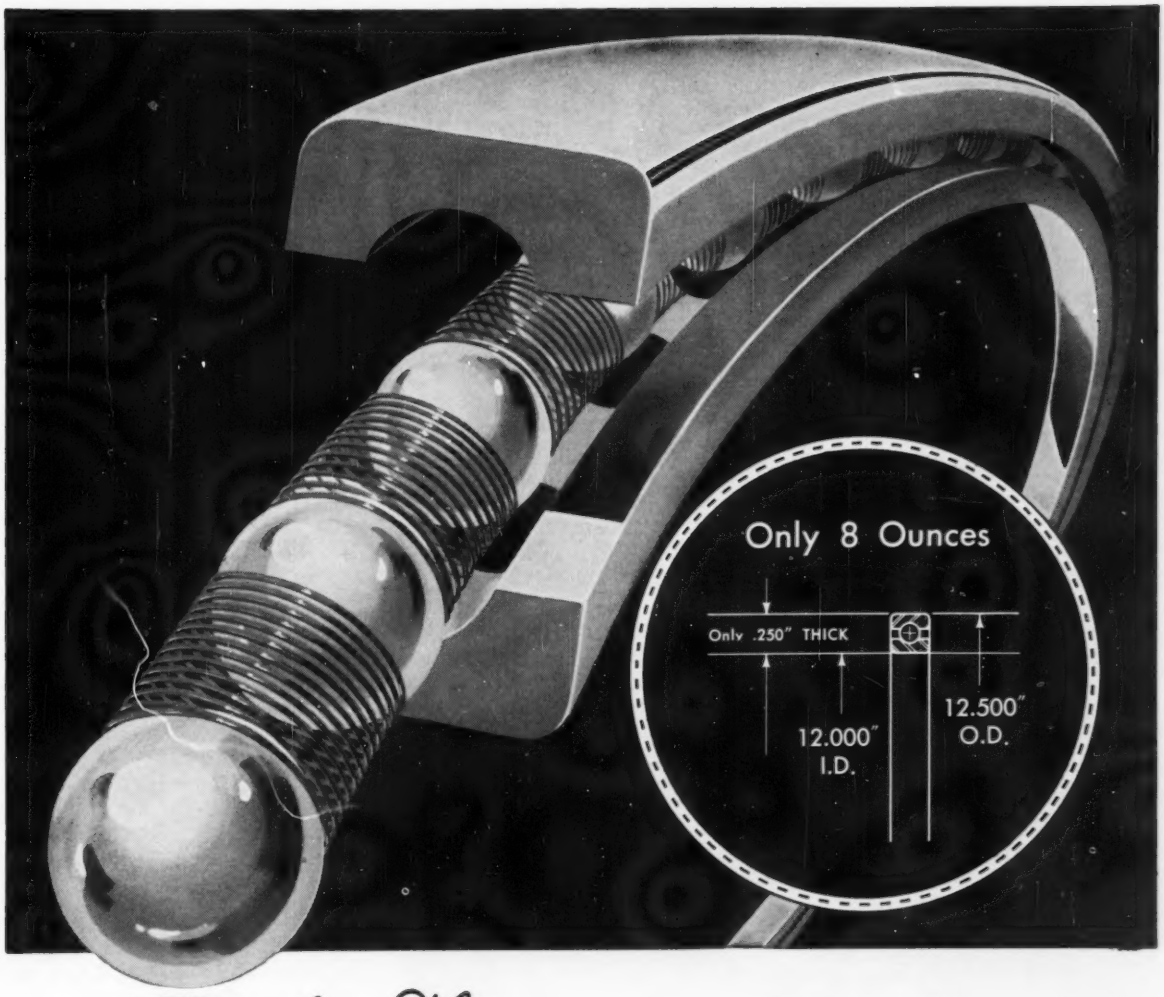


Reali-Slim... by Kaydon
world's thinnest radial ball bearing

HERE'S a typical example of Kaydon's *Reali-Slim* unique radial ball bearing that's finding wide application in practically every industry. *Reali-Slim* are the world's finest thin-section bearings and proportionately are thinner than a wedding ring. The bearing illustrated here is 12.000" I.D., 12.500" O.D., .250" thick — weighs less than 8 ounces. Designed for minimum weight and space limitations, it has a static load capacity of 5,520 lbs. and 894 lbs. at 100 rpm.

If you're looking for *Reali-Slim*, lightweight, radial ball or roller bearings, look at Kaydon's *Reali-Slim* line. Besides hundreds of standard *Reali-Slim* designs, there's a wide variety of special races, seals and separators to meet special bearing problems. What's more Kaydon is able to produce these *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual. In addition, Kaydon bearing engineers are prepared to give you valuable help with technical bearing application problems.

For complete data on *Reali-Slim* bearings for standard or special applications, ask for engineering Catalog No.54RS-2.

***Reali-Slim* Ball Bearings** — in Conrad, angular contact, 4-point contact and other types are available in seven standard cross sections from .250" to 1" and in bore diameters from 4" to 40".

***Reali-Slim* Roller Bearings** — in radial or taper roller types are available in cross sections from 9/16" and in bore diameters from 5" to 40".

K-554

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" to 120" outside diameter...
Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Needle Roller • Ball Radial • Ball Thrust Bearings.

Circle 413 on page 19

(*Continued from Page* 15)
of five different engine variables—air-fuel ratio, spark timing, manifold air pressure, engine speed, and compression ratio. Of these, air-fuel ratio is the most important factor affecting output of nitrogen oxides.

A lean mixture gives the motorist good fuel economy but the nitrogen oxide concentration rises. An enriched mixture produces opposite effects.

Nitrogen oxide concentrations could be limited with carburetor modification to provide maximum performance at all speeds and throttle settings. But disadvantages of this course of action include limited effectiveness, reduced fuel economy and greater carbon monoxide emission. The GM investigators caution that this approach is like taking several steps backward. Years ago carburetors having these characteristics were in common use.

R&D Lab Evaluates Factors That Mark Successful Engineer

Class standing, alone, found not significant. Valued men also have advanced degrees, join honor societies, write for journals

SAN FRANCISCO — It may be the nature of a profession that the value of its services is difficult to measure in terms of cold cash. Certainly, in establishing starting salaries, employers of engineers often find that they must evaluate a mass of personnel data without knowing what bits of this information should be bases for their decisions.

To make interviewing and evaluating more objective, those factors by which engineers and scientists could be compared fairly and consistently have been studied at Hughes Research and Development Laboratories. Results have been reported recently by Robert A. Martin and James Pachares. Their findings are based, implicitly, on the requirements and mission of the Hughes laboratory.

First investigated was the relationship between scholastic standing in college and success, as evidenced by salaries, after certain periods following graduation. The results:

"For the engineers with four years experience, there was barely significant positive correlation between class standings and salaries.

"For the engineers with six and eight years experience, there was no correlation whatsoever.

"For the engineers as a group, there was no correlation whatsoever."

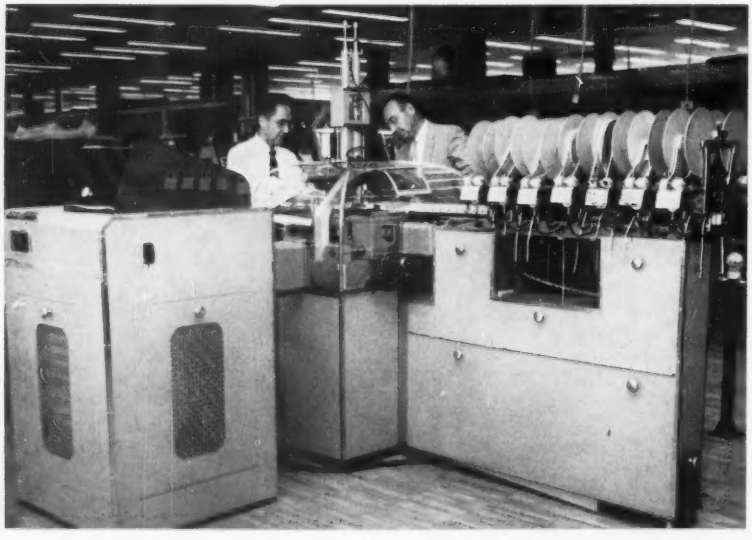
Believing that the standings of colleges may influence the survey, the researchers separated the alma maters of their subjects into three groups according to prestige. Then only the graduates from schools in the same group were compared. Again there was no relationship between engineers' scholastic standing and salaries.

These results indicated "that it really didn't make too much difference from which school the engineer graduated, at least as far as salaries were concerned."

When deans of engineering schools were confronted with these findings, they admitted, in effect, that "grades aren't everything." This response led the survey team to check all conceivable factors that could be "predictors" of success (earnings).

All in all, 27 predictors — the kind of data disclosed in employment interviews — were listed. "Predictands" — the factors, like starting salary, that the predictors might be expected to predict — numbered 11.

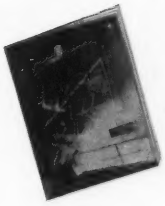
Of the hundreds of combinations



PRINTED-CIRCUIT ASSEMBLY MACHINE, developed by IBM, automatically fastens resistors, capacitors, diodes and other parts to printed wiring board at the rate of one part per second. Components are grouped according to type and electrical value, mounted on tape belts and wound on reels, machine gun fashion. Machine above has capacity of 20 reels, can be expanded to handle more. The system is programmed from IBM cards, can be reset for new layout and componentry by insertion of a new card, eliminating older methods of manual resetting. Key to successful design and operation is use of standardized printed panels and component dimensions. The Programmed Component Assembly System will accomodate any size panel ranging to 10 in. square, operates at an accuracy of better than 0.002-in. A two-directional servo system positions panels to receive parts.

ARISTOLOY LEADED BOOSTED PRODUCTION 44%

Lubricating effect permitted faster feeds and speeds



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A simple switch from 52100 to 52100 leaded by Universal Engineering Company for this bushing permitted spindle speeds to be increased from 234 to 351 R.P.M. Machine speed was upped from 65 to 90 S.F.M. and feed from .004 to .006 I.P.R. As a result, production of bushings jumped from 89 to 130 pieces per hour. On another bushing, the same lead-treated material increased production from 87 to 124.

In hundreds of like cases, Aristoloy Leaded, the steel with "built-in" lubrication, has helped cut machining time, increased tool life and yielded better finished parts.

Today, Copperweld offers a complete line of leaded analyses and experienced field metallurgists who will be glad to work with you to determine the best Aristoloy Leaded for cutting your machining costs.

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ARISTOLOY STEELS

Circle 414 on page 19

of 'or and ands,' 261 turned out to be significant. Some of the more interesting are:

Positive correlations:
- Entrance Rating (a basis for starting salary) and Maximum Rating
- Entrance Rating and Level of Degree
- Entrance Rating and Number of Fellowships
- Years of Experience and Salary
- Years of Experience and Number of Publications
- Change of Rating and Tenure
- Maximum Rating and Present Rating

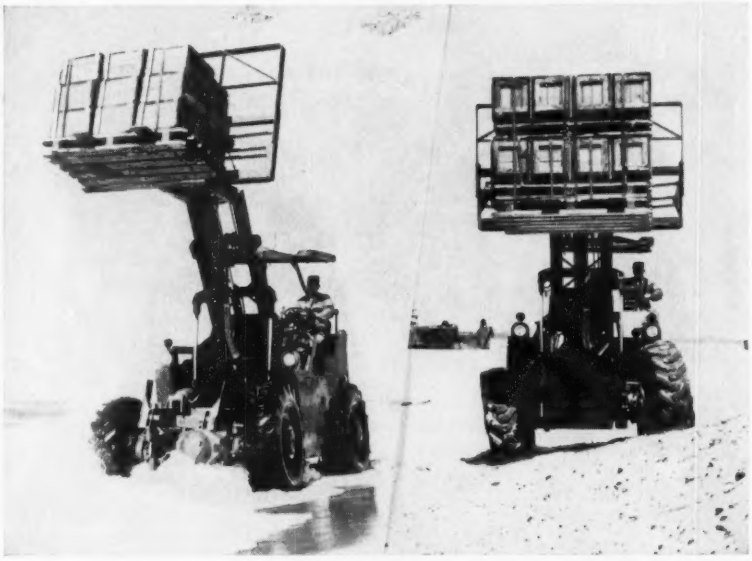
Negative Correlations:
- Length of service at Laboratories and Starting Salary
- Number of jobs prior to employment at Laboratories and Level of Degree
- Number of jobs prior to employment at Laboratories and Number of Honor Societies to which elected

Statistical screening enabled arrangement of significant predictors in order of importance (to the laboratory served by the study). Among the top eight were:
- Level of academic degree
- Number of professional publications
- Number of honor societies to which elected
- Major in Physics
- Major in E.E.
- Number of patents prior to Laboratories
- Number of fellowships

The Hughes researchers concede that much more investigation is needed before objectivity can be made a part of the art of evaluating engineers for employment, but they make these observations for the present:

1. *Scholarship,* although not significant in terms of *class standing,* is definitely an important factor in determining entrance rating (which, in turn, determines starting salary). In evidence, such predictors as level of academic degree, number of professional publications, number of patents, and number of fellowships were all found to be statistically significant.

2. Such factors as class standing, participation in extra-curricular activities, particular college, and number of dependents do not affect salary growth.



ROUGH-TERRAIN FORK TRUCK, designed for the Army by Clark Equipment Co., has unique operational and mechanical characteristics. It will operate in 5 ft of water. With both front and rear axle steering, it can move sideways at a 20-deg angle. Body and forks can be tilted left or right, independent of axles, to permit pick-up of loads set at an angle, or to carry loads at a level across an incline. There is no conventional upright. Forks are extensions of hydraulic telescoping "arms" which reach out, up or down to pick up loads. A side-shifting device moves forks 2 ft either side of center to lift off-center loads. Forks also act as a built-in jack; can be pushed into the ground to lift front wheels free while the truck backs off. An oscillating rear axle keeps truck level when passing over bumps or depressions. Truck has both two and four-wheel drive with spot type disc brakes.

Sara, Automatic Girl Watchman Sees, Remembers, and Tells

CLEVELAND—SARA, an automatic girl watchman built by Taller & Cooper Inc., has an electronic "brain" that checks and "remembers" at the rate of 80,000 events per second. More formally named Sequential Automatic Recorder and Annunciator, SARA monitors automatically controlled and instrument-supervised equipment in power stations, utilities, and large

Just Out! *New, 75 f.p.m. Bruning Copyflex Model 575!*

- Makes sharp, black-line whiteprints at extra high speeds
- Exposure lamp operates at either 7,500 or 5,000 watts
- Many operator conveniences—including one-knob speed control

Here is the fastest, easiest-to-use Copyflex machine ever built!

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More Operator Conveniences. A host of time-saving conveniences include: one-knob speed control with perfect automatic synchronization of print exposure and development, automatic separation of exposed prints from originals, automatic stacking of tracings and prints, front or rear delivery, and a lamp shield control that facilitates reproduction of extra-fast printing originals.

Like all Copyflex machines, new Model 575 offers problem-free installation and operation—no exhaust venting, no plumbing, no auxiliary equipment. It's the greatest Bruning machine ever built. It offers you the greatest savings ever in time and man hours! Mail coupon below for special literature offer.

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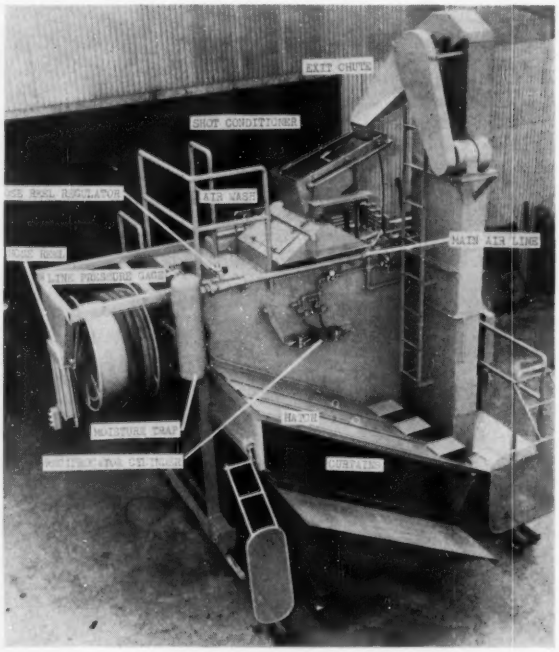
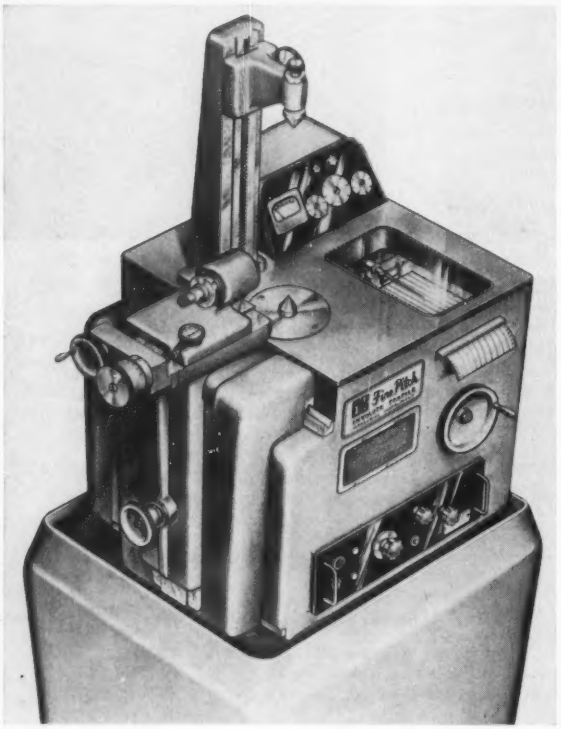


Above

TRAVELING-CARRIAGE PEEN FORMING, claimed first-of-type, bends large aircraft panels of integrally stiffened aluminum alloy with tapered skin thickness, tapered plan form, and occasional cutouts. Peen forming reduces susceptibility of aluminum alloy parts to stress corrosion and corrosion fatigue as compared to forming processes involving "springback," claims the Metal Improvement Co. Their Peenamatic Model No. 706, a self-propelled traveling carriage 12 ft long will travel on rails mounted on 96-ft worktable. Shot powered by compressed air is directed through 10 nozzles reciprocating above the workpiece. Spent shot is automatically recovered, washed and reused.



Above, left

CRITICAL FLATNESS AND PARALLELISM in the production of high-frequency crystals and wafers is obtained with lapping fixture offered by the Lapmaster Div. of Crane Packing Co. Attainable are a flatness under three light bands, parallelism of 50 mu in. and thinness of 0.001 in. Here are fixture and wafers.

Left

FINE BUSINESS is this first involute profile measuring instrument capable of checking fine-pitch gears. Micrite (TM) built by the Machine and Instrument Div. of Illinois Tool Works has electrical measuring head with easily adjustable contact-finger load range from 3 to 30 grams, integral recording system, and new "change" gear principle to accommodate various work gear base diameters. Magnifies error up to 1600 to 1.

plants where petroleum, paper, plastics, or chemicals are processed.

SARA monitors any number of points and prints a continuous record of deviations from the norm immediately after they occur. Because data are printed in chronological order, spotting the trouble source is often simplified.

For example, a power plant steam boiler may develop a fault

Atom Angles

Atmospheric sampling at high altitudes, and analyzing of radioactive debris collected, will be conducted by the Department of Defense. This program will supplement the Atomic Energy Commission's high altitude sampling. It is designed to determine the distribution, movement, retention, and total amount of radioactive particles placed in the upper atmosphere by nuclear detonations. Results will be correlated with data obtained by the AEC's sampling programs.

• • •

Spanish reactor core and components are planned for testing in new facility at General Electric Company's Vallecitos Atomic Laboratory in Alameda County, Calif., to be constructed under permit of the Atomic Energy Commission. Test will be performed at a power level of 50 w. The pool-type reactor of 3000 thermal kw capacity using uranium enriched to 20 per cent in the isotope U-235 as fuel, is for the Junta de Energia Nuclear, Spain's Atomic Energy Commission.

• • •

Private industry service at a reasonable price is reason Atomic Energy Commission will discontinue encapsulation service to public for large sources of radioactive cobalt-60. Effective March 1, 1958, this action is in line with the Commission's general policy to discontinue furnishing materials and services when they become reasonably available commercially. Private industry already provides encapsulation—sealing into metallic capsules—service for smaller cobalt-60 sources. Companies which so far have indicated intent to enter the business of large-source encapsulation are Nuclear Systems of Philadelphia and Picker X-Ray Co. of Cleveland.

Reactors for aircraft propulsion, including fuel elements and other components will be primary studies in a large testing reactor to be built near Sandusky, Ohio, by the National Advisory Committee for Aeronautics.

The reactor is a modification of the Atomic Energy Commission's Materials Testing Reactor (MTR) in Idaho. It will be composed of a core contained in a reactor pressure tank shielded by concrete and water in a circular pool, further contained in a cylindrical steel tank. Maximum thermal power will be 60,000 kw.

NACA will both design and build the new reactor. Operation of the $10,735,000 facility will be supervised by the NACA Lewis Flight Propulsion Laboratory, Cleveland. Present schedules call for completion in 1959.

• • •

New radiation control firm has been organized in Cambridge, Mass., under the name of Controls for Radiation, Inc. President is Wm. E. Barbour Jr., founder and former president and chairman of Tracerlab, Inc. The company will provide comprehensive service covering the hazards control aspects of the nuclear industry.

• • •

Growth of peacetime uses of atomic energy was marked recently with shipment of the 100,000th package of radioisotopes from the Oak Ridge National Laboratory. Since inauguration of the radioactive material distribution program in 1946, more than 4000 organizations have been licensed to use radioisotopes; many others have received small quantities under general license. The 100,000th package, 75 millicuries of potassium-42 (half-life, 12.4 hours), was flown to the University of Iowa for use in medical research.

that causes it to shut down. This stops a turbine, which in turn halts a generator. All of this occurs within a split second, but perceptive SARA, with her ability to respond almost instantly, stores the memories in sequence, and at 2 or 3-second intervals graphically tells all.

SARA may be used alone for recording or in combination with data logger.

more

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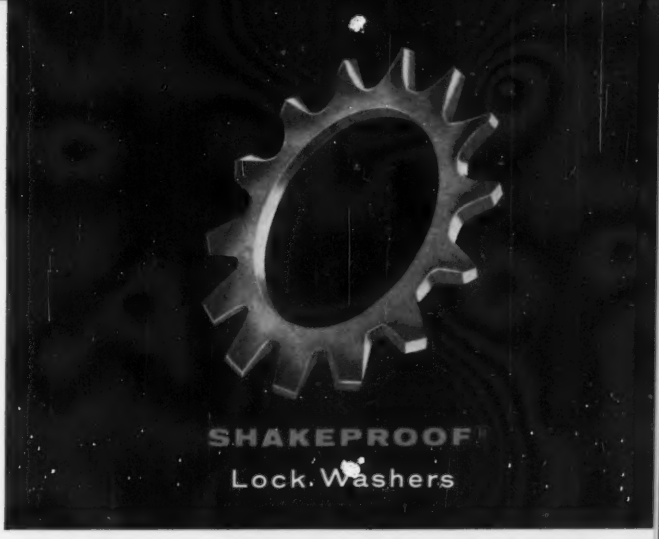
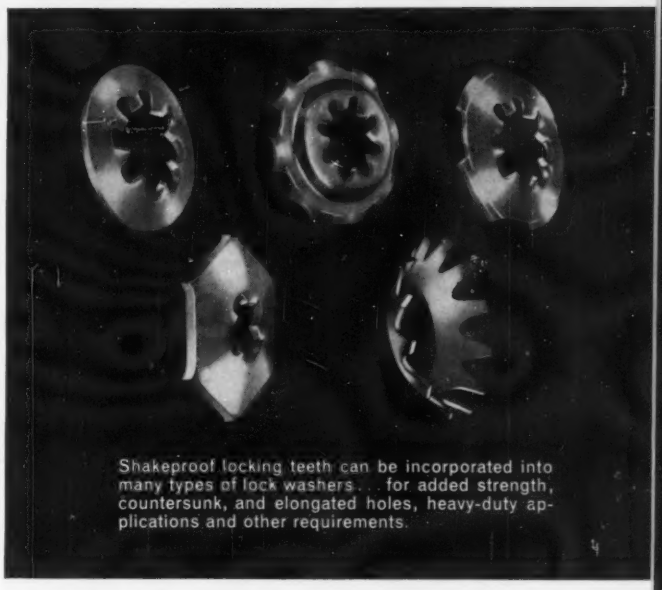
...than any other washer or washer substitute





Shakeproof locking teeth can be incorporated into many types of lock washers . . . for added strength, countersunk, and elongated holes, heavy-duty applications and other requirements.

- Shakeproof Lock Washers assure maximum vibration protection for your product
- Exclusive tapered-twisted teeth resist loosening • Assure maximum locking engagement • Form positive brace against rotation • Resist shock
- Available in nearly 500 job-tailored styles and wide size range.

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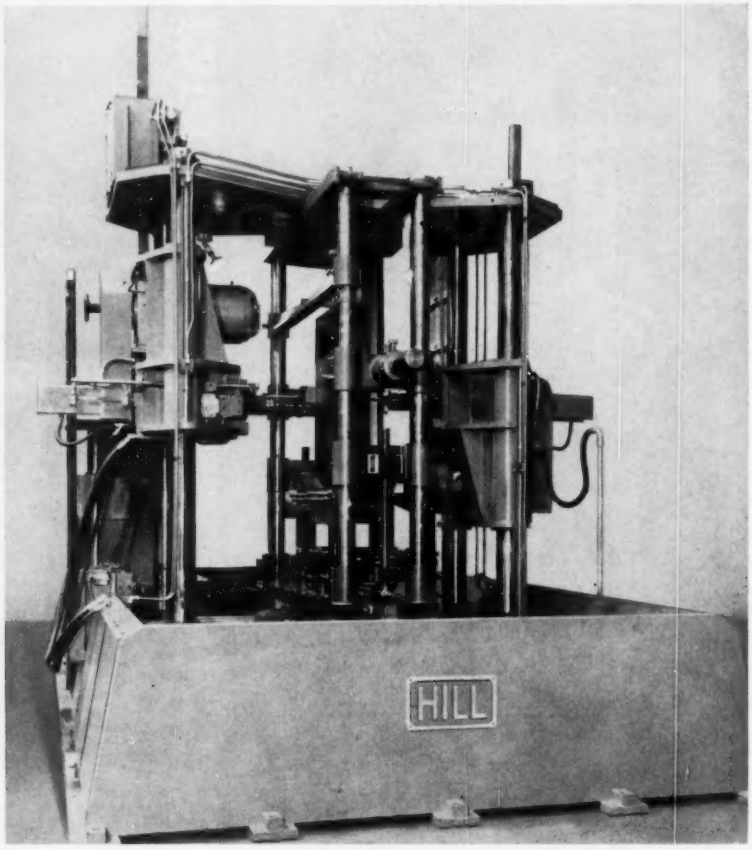
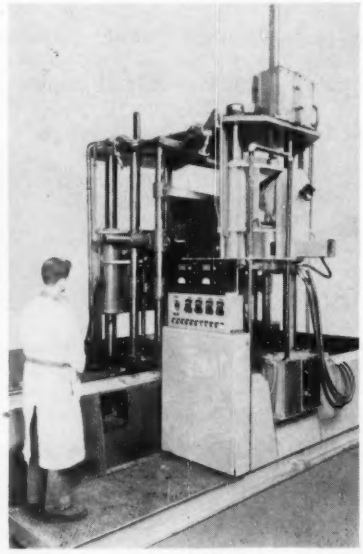


Automatically positioned opposed spindle drilling machine has two hydraulic power heads mounted opposite each other. Each head travels vertically on a pair of 6-in. diam solid steel columns. The work fixture is mounted on a table having positively lubricated bronze steel-backed ways that travel on ground ways hardened to Rockwell 67 C scale. Hardened, self-contained roller followers guide the fixture at the top during indexing and maintain fixture alignment with the drill heads to prevent holes made out-of-round.



Add Automatic Positioning To Opposed-Spindle Drilling

Assures Accurate Alignment of Complex Hole Patterns

DETROIT—Heads and table are automatically positioned in Walter P. Hill, Inc., opposed-spindle drilling machine which produces holes at feed rates up to 18 in. per minute. With the accurate positioning system, tube sheets and baffles are drilled separately or stacked with assurance of accurate alignment at assembly. The machine will handle stock up to 6-ft diam and 10 in. thick.

Both head and table index functions are controlled by individual escapement wheels, shaved gears,

Circle 420 on page 19→

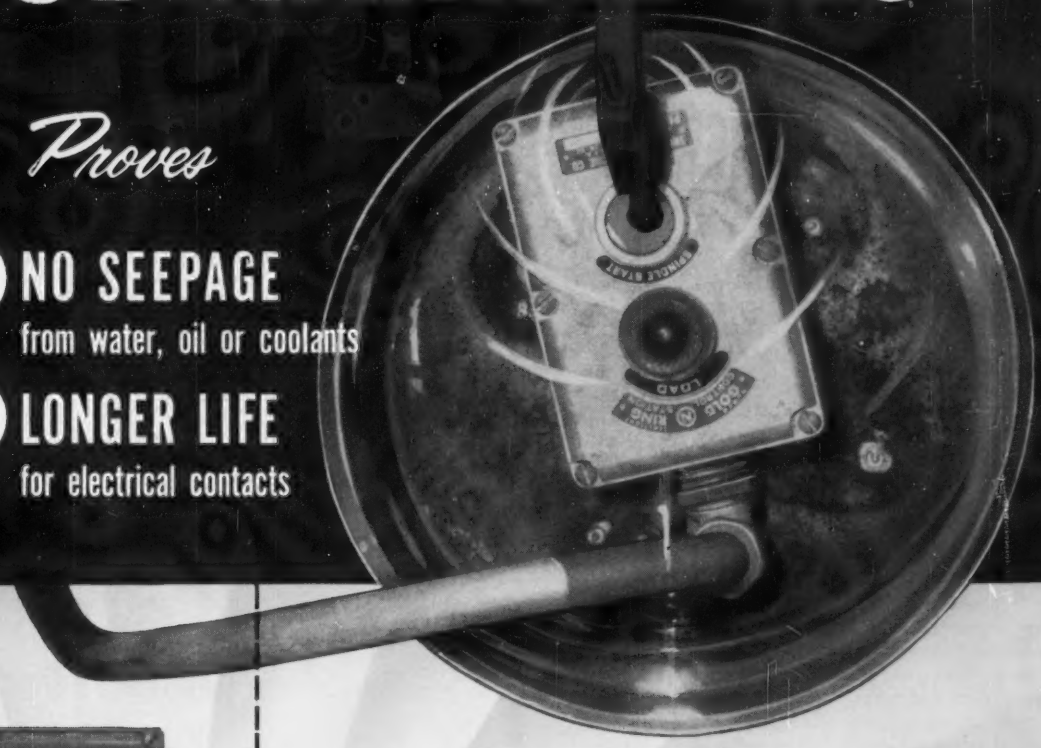
1,500,000 CYCLE

SUBMARINE TEST

Proves

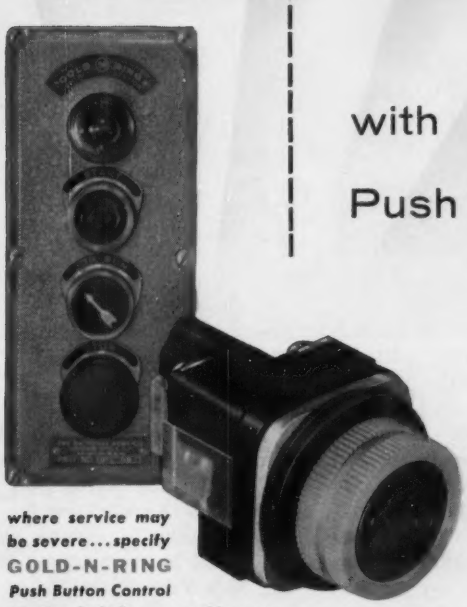
1. **NO SEEPAGE**
from water, oil or coolants

2. **LONGER LIFE**
for electrical contacts



with THE NAMCO SEALTIGHT GOLD N RING

Push Button Control Station Switch



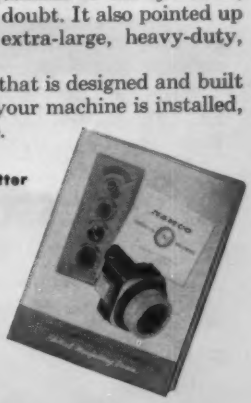
where service may be severe... specify **GOLD-N-RING** *Push Button Control Station Switches... and be sure*

This test simulated conditions much more severe than even the most demanding electrical control service would ever duplicate. Without once "coming up for air," this standard GOLD-N-RING 2-unit control switch was immersed in fluid for more than 338 hours, during which momentary electrical contact was made 1,500,000 times—at the rate of 64 cycles per minute.

This test proved the flexing qualities of the synthetic, oil-resistant diaphragm beyond a doubt. It also pointed up the "staying qualities" of the extra-large, heavy-duty, alloy silver electrical contacts.

If you are looking for a switch that is designed and built to *keep on performing* long after your machine is installed, you'll find we talk your language.

Ask us to send Catalog ECS-56—or, better yet, ask a representative to call.



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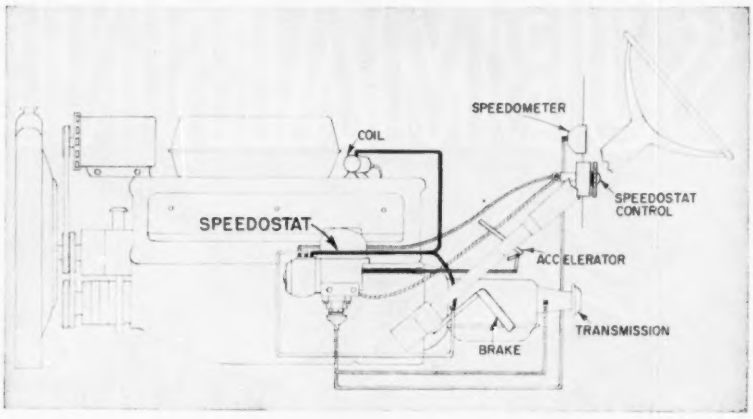
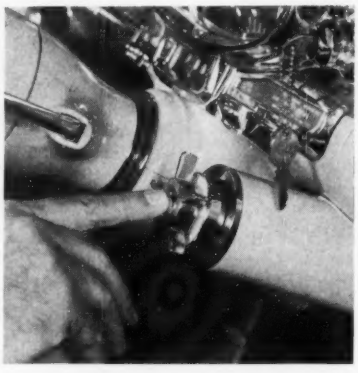
Engineering News Roundup



SPEEDOSTAT will be available on several makes of 1958 cars to eliminate some of the footwork in driving. Developed by Perfect Circle Corp., the electromechanical device is featured as a driving and safety aid. Driver selects a cruising speed from dial on the dashboard, below. When car attains preselected speed, warning back-pressure develops on the accelerator to act as a speed reminder. In emergency, back-pressure can be easily overridden to increase speed. For longer cruising, Speedostat can be set to automatically control the throttle. The device will maintain a preselected speed up-hill or down. A touch of the brake pedal releases the "hold speed" feature. In schematic, above, speed control is driven by the transmission and brought into action by the speed selector on the dashboard. A reversible electric motor activates the linkage to accelerator pedal and carburetor.



racks, and pinions. New hole spacings for different patterns are set by inserting suitable change gears.

Individual hydraulic cylinders are used to index the heads and table. The two power heads are vertically indexed by automatic operation of electrically controlled hydraulic cylinder that releases the escapement wheel for vertical head travel. As one head index cylinder is raised, other is lowered, and escapement wheel is rotated to the next index position. The table is positioned by a similar system for horizontal location.

Meetings

AND EXPOSITIONS

Oct. 14-15—

Fourth Conference on Mechanisms to be held at Purdue University, West Lafayette, Ind. Sponsors are the Purdue School of Mechanical Engineering and MACHINE DESIGN. Additional information can be obtained from the Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

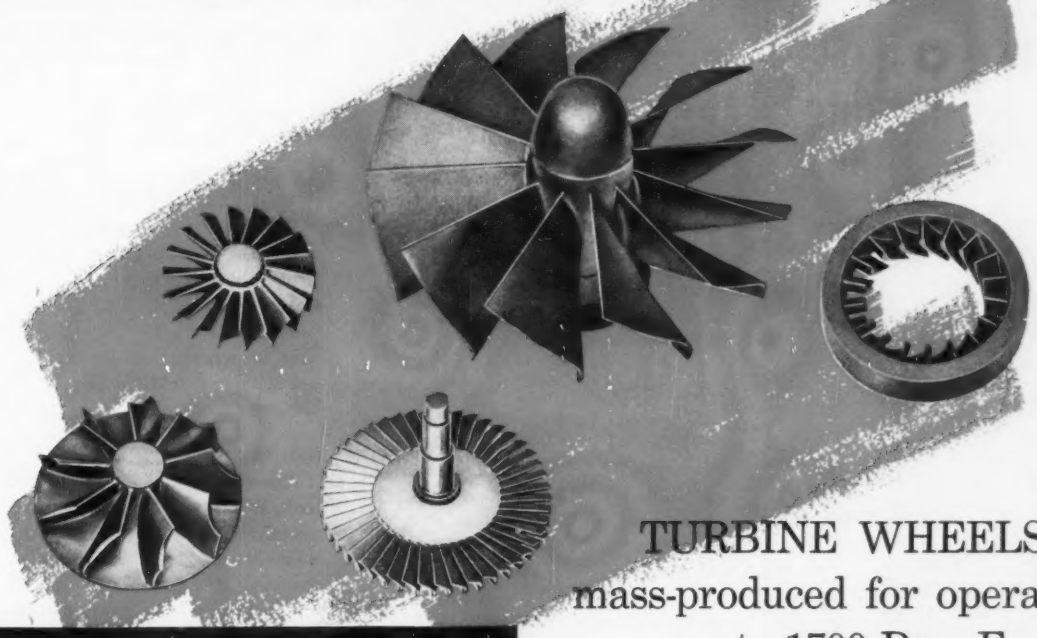
Oct. 16-18—

Institute of Radio Engineers. Canadian Convention-Exposition to be held in the Automotive Bldg., Exhibition Park, Toronto. Further information can be obtained from IRE headquarters, 1 E. 79th St., New York 21, N. Y.

Oct. 17-18—

Magnesium Association. Annual Convention to be held at the Biltmore Hotel, New York. Additional information can be obtained from

HAYNES investment casting solves the *tough* design problems



TURBINE WHEELS mass-produced for operation up to 1700 Deg. F

Special inspection equipment guarantees accuracy. Examinations by Gamma Ray (above) is one of a number of inspection methods used at Haynes Stellite Company's plant to insure top quality control.

Turbine wheels with intricate blading—some as thin as 0.020 in.—and ranging in diameter from 2 to 21 in. are now mass-produced economically by HAYNES' investment-casting method. The blades and wheel are produced as one integral part to close as-cast tolerances.

HAYNES' investment-casting method offers the design engineer a selection of alloys developed for economical operation over a wide temperature range—from room temperature to 1700 deg. F. The cast wheels have high strength and are capable of operating at speeds in excess of 42,000 revolutions per minute.

The freedom to select alloys for performance and to design for top efficiency is one of the big advantages of HAYNES' investment-casting process. For full details, write for the booklet "HAYNES' Investment-Casting." Address Haynes Stellite Company, Division of Union Carbide Corporation, General Offices and Works, Kokomo, Indiana.

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Engineering News Roundup

association headquarters, 122 E. 42nd St., New York 17, N. Y.

Oct. 17-18—

National Conference on Industrial Hydraulics to be held at Hotel Sherman, Chicago. Sponsors are Armour Research Foundation and Illinois Institute of Technology. Further information is available from Conference Secretary, Armour Research Foundation, 10 W. 35th St., Chicago, Ill.

Oct. 17-19—

National Society of Professional Engineers. Fall Meeting to be held at Grand Pacific Hotel, Bismarck, N. Dak. Further information can be obtained from society headquarters, 2029 K St. N.W., Washington 6, D. C.

Oct. 17-19—

Foundry Equipment Manufacturers Association Inc. Annual Meeting to be held at The Greenbrier, White Sulphur Springs, W. Va. Further information is available from association headquarters, 1 Thomas Circle, Washington 5, D. C.

Oct. 21-23—

American Society of Mechanical Engineers. Power Conference to be held at the Americus Hotel, Allentown, Pa. Additional information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Oct. 23-25—

National Fluid Power Association. Fall Meeting to be held at Hotel Statler, Washington, D. C. Additional information can be obtained from association headquarters, 1618 Orrington Ave., Evanston, Ill.

Oct. 24-25—

Aircraft Electrical Society. 14th Annual Display of Aircraft Electrical Equipment to be held in the Pan Pacific Auditorium, Los Angeles. Additional information is available from Edward Ryerson, Display Director, 380 Entrada Dr., Santa Monica, Calif.

Oct. 27-30—

American Gear Manufacturers Association. Fall Meeting to be held at the Edgewater Beach Hotel, Chicago. Further information is available from AGMA headquarters, 1 Thomas Circle, Washington 5, D. C.

Oct. 28-31—

Society of Industrial Packaging and Materials Handling Engineers. National Packaging and Handling Exposition to be held at Convention Hall, Atlantic City, N. J. Further information is available from society headquarters, Suite 759, 1 Gateway Center, Pittsburgh 22, Pa.

Oct. 28-31—

American Nuclear Society. Second Winter Meeting to be held concurrently with the Fourth Annual Meeting of the Atomic Industrial Forum and the Third Trade Fair of the Atomic Industry at the Coliseum, New York. Additional information can be obtained from John Burt, J. M. Mathes Inc., 260 Madison Ave., New York 16, N. Y.

Oct. 30—

Aircraft Electrical Society. First Annual Display of Aircraft Electrical Equipment to be held at U. S. Grant Hotel, San Diego, Calif. Additional information can be obtained from Tom Harrower, Exhibit Director, 5457 Bradna Dr., Los Angeles, Calif.

Nov. 2-8—

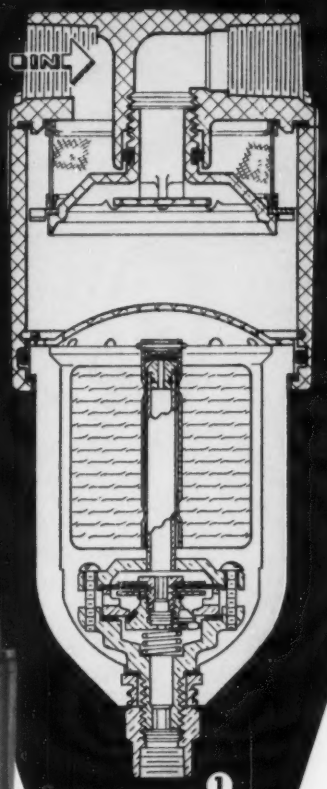
National Metal Exposition and Congress to be held at the International Amphitheatre, Chicago. The American Society for Metals; the Institute of Metals Div. of the American Institute of Mining, Metallurgical and Petroleum Engineers; and the Society for Nondestructive Testing will hold technical sessions.

Second World Metallurgical Congress will be held in conjunction with the Metal Show. Information on both meetings can be obtained from ASM headquarters, 7301 Euclid Ave., Cleveland 3, Ohio.

Nov. 4-6—

American Institute of Electrical Engineers. Machine Tool Conference to be held at the Hotel

NEW Advanced design Norgren AUTOMATIC-DRAIN AIR LINE FILTERS



NOW—24 Models to choose from

- Transparent Bowls—¼", ⅜", ½", ¾", 1"
- Metal Bowls—¼", ⅜", ½"

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2 WIDER OPERATING RANGE 5 psi to 250 psi, up to 200° F.

BETTER... MORE EFFICIENT FILTRATION OF COMPRESSED AIR

You Get These Important Advantages:

- **More Efficient Water Removal**
  Greatly increased water removal efficiency—even at air flows 143% higher than ever before.
- **Operates Over Wider Pressure Range**
  Top efficiency at as low as 5 psi for all models and as high as 250 psi for metal bowl type.
- **Operates Over Wider Temperature Range**
  New metal bowl models in ¼", ⅜" and ½" sizes extend temperature range to 200° F.
- **Withstand Rougher Usage**
  Metal bowl models are ideal for applications likely to get rough usage.
- **Simplified Drain Mechanism**
  More efficient operation. Fewer parts.
- **Eliminates Manual Draining**
  Collected liquid is drained automatically—cannot return to air line. Drain operates as long as pressure is on the system.
- **Choice of Three Filter Elements**
  74, 64 or 25 micron elements—interchangeable.

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Engineering News Roundup

Schroeder, Milwaukee. Additional information can be obtained from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Nov. 4-6—

Society of Automotive Engineers Inc. Transportation Meeting to be held at Hotel Statler, Cleveland. Additional information is available from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Nov. 5-6—

Society of Automotive Engineers Inc. Diesel Engine Meeting to be held at Hotel Statler, Cleveland. Further information is available from society headquarters, 485 Lexington Ave., New York 17, N. Y.

"Why yes, Henry has changed his job again — how did you guess?"

Nov. 6-8—

Society of Automotive Engineers Inc. Fuels and Lubricants Meeting to be held at Hotel Statler, Cleveland. Further information is available from SAE, 485 Lexington Ave., New York 17, N. Y.

Nov. 11-13—

Steel Founders' Society of America. Twelfth Technical and Operating Conference to be held at the Carter Hotel, Cleveland. Further information is available from society headquarters, 606 Terminal Tower, Cleveland 13, Ohio.

Nov. 11-15—

National Electrical Manufacturers Association. Annual Meeting to be held at the Traymore Hotel, Atlantic City, N. J. Additional information is available from NEMA headquarters, 155 E. 44th St., New York 17, N. Y.

Nov. 13-15—

American Standards Association. 39th Annual Meeting and Eighth National Conference on Standards to be held at the St. Francis Hotel, San Francisco. Additional information is available from association headquarters, 70 E. 45th St., New York 17, N. Y.

Nov. 18-20—

Conference on Magnetism and Magnetic Materials to be held at the Sheraton-Park Hotel, Washington. Conference is sponsored by the American Institute of Electrical Engineers in co-operation with the American Physical Society; the American Institute of Mining, Metallurgical and Petroleum Engineers; the Institute of Radio Engineers; and the Office of Naval Research. Further information is available from L. R. Maxwell, U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

Nov. 18-21—

Air Conditioning and Refrigeration Institute. Tenth Air Conditioning and Refrigeration Exposition to be held at the International Amphitheatre, Chicago. Additional information can be obtained from R. H. Israel, Virginia Smelting Co., West Norfolk, Va.

Dec. 1-6—

American Society of Mechanical Engineers. Annual Meeting to be held at the Statler and Sheraton McAlpin Hotels, New York. Further information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

Dec. 2-6—

26th Exposition of Chemical Industries to be held at the Coliseum, New York. Additional information is available from exposition headquarters, 480 Lexington Ave., New York 17, N. Y.

Circle 426 on page 19→

The story of plus value in Roller Chain...

written on the end of a pin

To provide the long wear life and fatigue resistance you expect from a roller chain, the pins *must* have two characteristics:

One...a case-hardened surface for longest wear life plus a tough, resilient core for shock load resistance.

Two...comparatively soft ends for secure riveting and maximum holding power in the link plates.

How can you have these two opposites in one pin?

In Rex Roller Chains, the pins are completely copper-plated. Then, the copper is ground off only the pin body, leaving the pin ends plated. Next, they're carburized in controlled-atmosphere gas furnaces. Since copper will not absorb carbon during heat treatment, the pin ends are not hardened...remain relatively soft. The pin body gets the file-hard case depth you need.

Look for the *copper-plated pins* before you buy roller chain. They're visible evidence of the *plus* value in Rex Roller Chains. For the story on the "finest roller chains made," mail the coupon. CHAIN Belt Company, 4643 W. Greenfield Ave., Milwaukee 1, Wis.

CHAIN Belt Company
4643 W. Greenfield Ave., Milwaukee 1, Wis.
☐ Send me my copy of Catalog No. 610.
☐ Have CHAIN Belt Man call.

Name.....

Company.....

Address.....

City.....*Zone*.....*State*.....

CHAIN BELT

Leadership...through creative engineering

Circle 427 on page 19

There's a G-E TRI 55 CLAD motor for

FOUR BASIC

STANDARD ENCLOSED NON-VENTILATED Tri/Clad '55' motors are designed in 1 and 1½ horsepower ratings for operation under most outdoor conditions and in industrial atmospheres containing metallic dust, dirt and moisture. As all Tri/Clad '55' enclosed motors, these motors have rigid cast-iron frames and end-shields. Rabbet fits are moisture sealed for even greater motor protection.

your toughest applications!

General Electric announces new severe-duty enclosed motors in ratings from 1 to 5 horsepower, giving you a more complete line of Tri/Clad '55' enclosed motors to choose from.

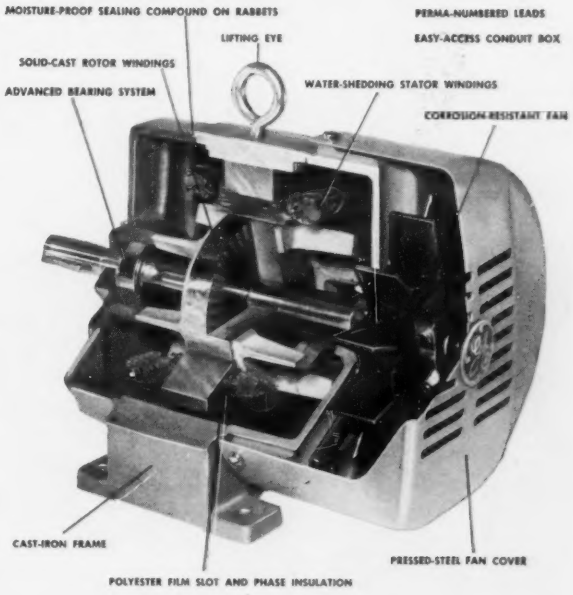
Whether you need a standard enclosed, severe-duty, or explosion-proof motor, General Electric has the rating you need. From G.E.'s complete line—the most complete in the industry—you are better assured of getting the "right" motor for your toughest applications.

Of course, G-E enclosed motors offer you all the outstanding features of the Tri/Clad '55' line including Mylar* polyester film insulation for longer life, minimum maintenance; non-wicking leads and silicone stator coating for maximum moisture protection; Formex† magnet wire for greater protection against heat-aging and abrasive dust; and many, many more.

Because they're built for better protection, longer life, easier installation and minimum maintenance: G-E Tri/Clad '55' *totally* enclosed motors are your best buy.

For more information on the "right" motor for your applications, contact your G-E Apparatus Sales Office or Distributor. Or, write to Section 840-8, General Electric Company, Schenectady, N. Y. for bulletins GEA-5980 and GEA-6341. For enclosed motors above 5 hp, ask for GEA-6602.

*Registered Trade-mark of the DuPont Co.
†Registered Trade-mark of the General Electric Co.

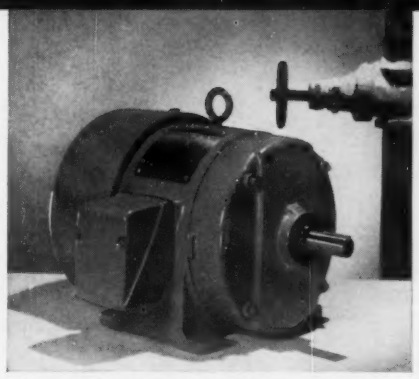


Standard enclosed fan-cooled Tri/Clad '55' motor.

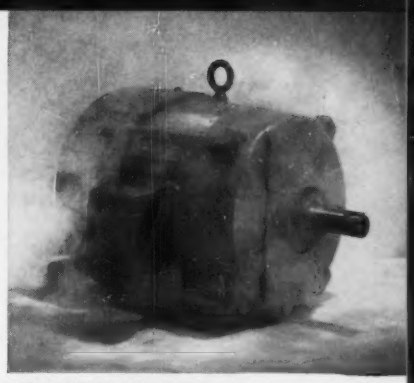
GENERAL ELECTRIC

TRI 55 CLAD ENCLOSED MOTORS AND WHERE TO USE THEM

STANDARD ENCLOSED FAN-COOLED Tri/Clad '55' motors, designed for operation under the same conditions specified for the standard enclosed non-ventilated motors, are available in ratings from 2 to 5 horsepower. Features include rugged, pressed-steel fan cover; non-sparking fan; and pressed-steel conduit box with keyhole slots for all-position mounting.



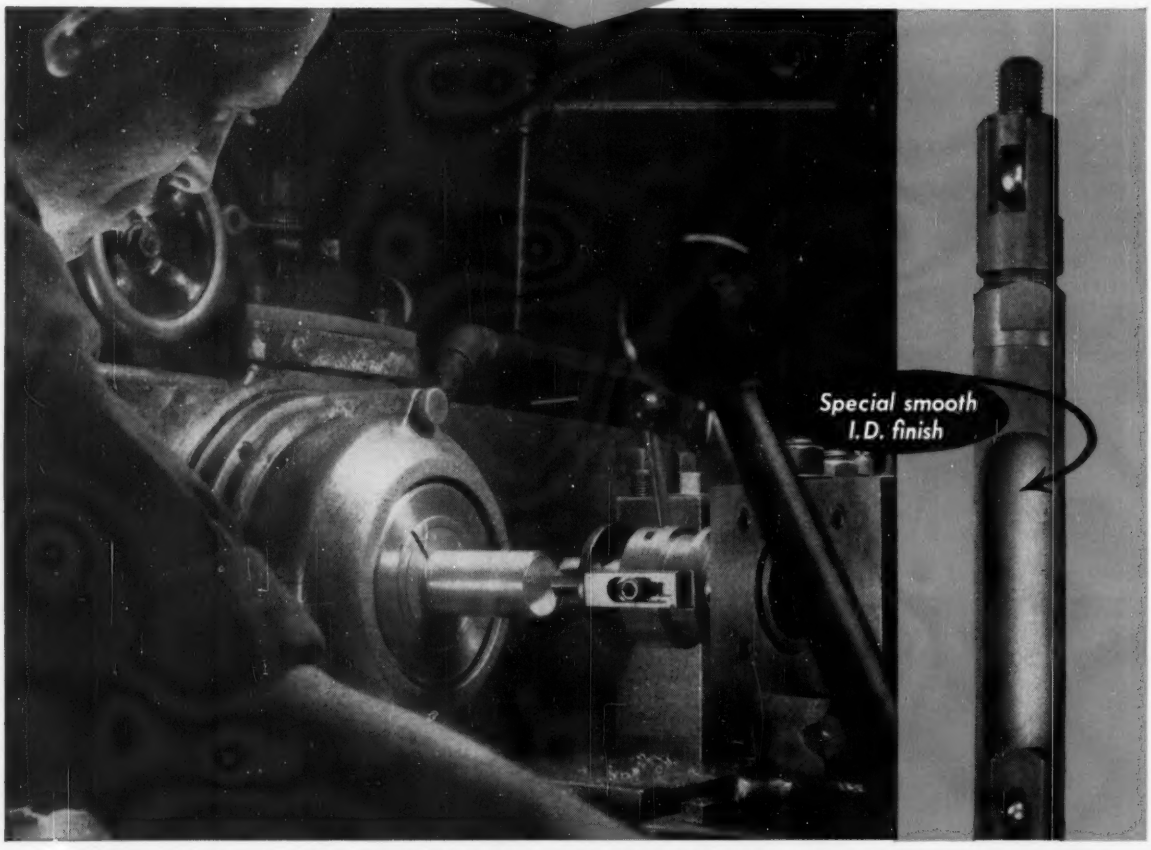
SEVERE-DUTY ENCLOSED Tri/Clad '55' motors are available in both fan-cooled and non-ventilated designs for applications in chemical atmospheres and other areas in which highly corrosive or excessively moist conditions are encountered. Available in ratings from 1 through 5 horsepower, General Electric severe-duty motors feature all cast-iron construction, external neoprene slinger, and complete gasketing for greater motor protection.



EXPLOSION-PROOF Tri/Clad '55' motors are designed for safer operation in atmospheres containing gases or dust which threaten explosion or serious damage in the event of an electrical spark. G-E explosion-proof motors are U. L. listed, and each feature a non-sparking fan; long, close rabbet fits; sealed lead entrance; and dust-tight labyrinth shaft seal.

Circle 428 on page 19

This pump manufacturer reports 25% savings with J&L COLD DRAWN ELECTRICWELD TUBING



Operator is threading 1¾" O.D. x 1½" I.D. J&L special smooth *cold drawn* Electricweld tubing for pump cylinder.

Low original cost and elimination of interior honing are two reasons why it pays you to specify J&L *cold drawn* Electricweld tubing with special smooth I.D. finish.

This manufacturer of oil well insert pumps reports a saving of 25% by converting from honed seamless tubing to *cold drawn* special smooth I.D. Electricweld tubing. Not a single tube failure has been reported from the field.

Because of its superior inside surface finish, exact tolerances and closely controlled physical characteristics, J&L *cold drawn* Electricweld tubing is recommended for these applications:

- *cylinder tubing* • *shock absorbers*
- *ordnance parts* • *hydraulic and pressure tubing*

J&L *cold drawn* Electricweld tubing is readily available in diameters from ¾" O.D. to 4¼" O.D., 8 gage to 20 gage, and can be furnished to closer than commercial tolerances. Write to Jones & Laughlin, 3 Gateway Center, Pittsburgh 30, Pa.

Jones & Laughlin STEEL ... a great name in steel

Circle 429 on page 19

TIME CLOCKS DON'T STOP WHEN YOUR LINE IS "DOWN"

by H. D. Dorfman
Westinghouse Electric Corporation

Automation brings many new considerations to the maintenance of electrical systems for production plants. A pertinent example is the increasing importance of engineered protective devices.

A great deal more than ampere load supervision is required to protect electrical circuits serving automatic production units. Mobile assembly lines, interlocked with sub-assembly and component feeder carriers, represent a cost per minute that makes insurance against stoppage very important. That is why those of us concerned with the production of circuit protective equipment "harp" on the advantages of circuit breakers. Two of the cost-saving features are:

*Prevention of power interruption resulting from harmless, temporary current surges.

*Speed in restoration of power after an interruption.

Breakers More Accurate

Breakers avoid false stoppages in many ways. One is accurate calibration. There is a correct breaker for each particular current load and environmental condition. Exacting tests at our plant insure its being right before delivery.

Where temperature variations affect breaker ratings, but not conductor ratings, ambient-compensated breakers should be specified as additional insurance against current interruptions due to false temperature influences.

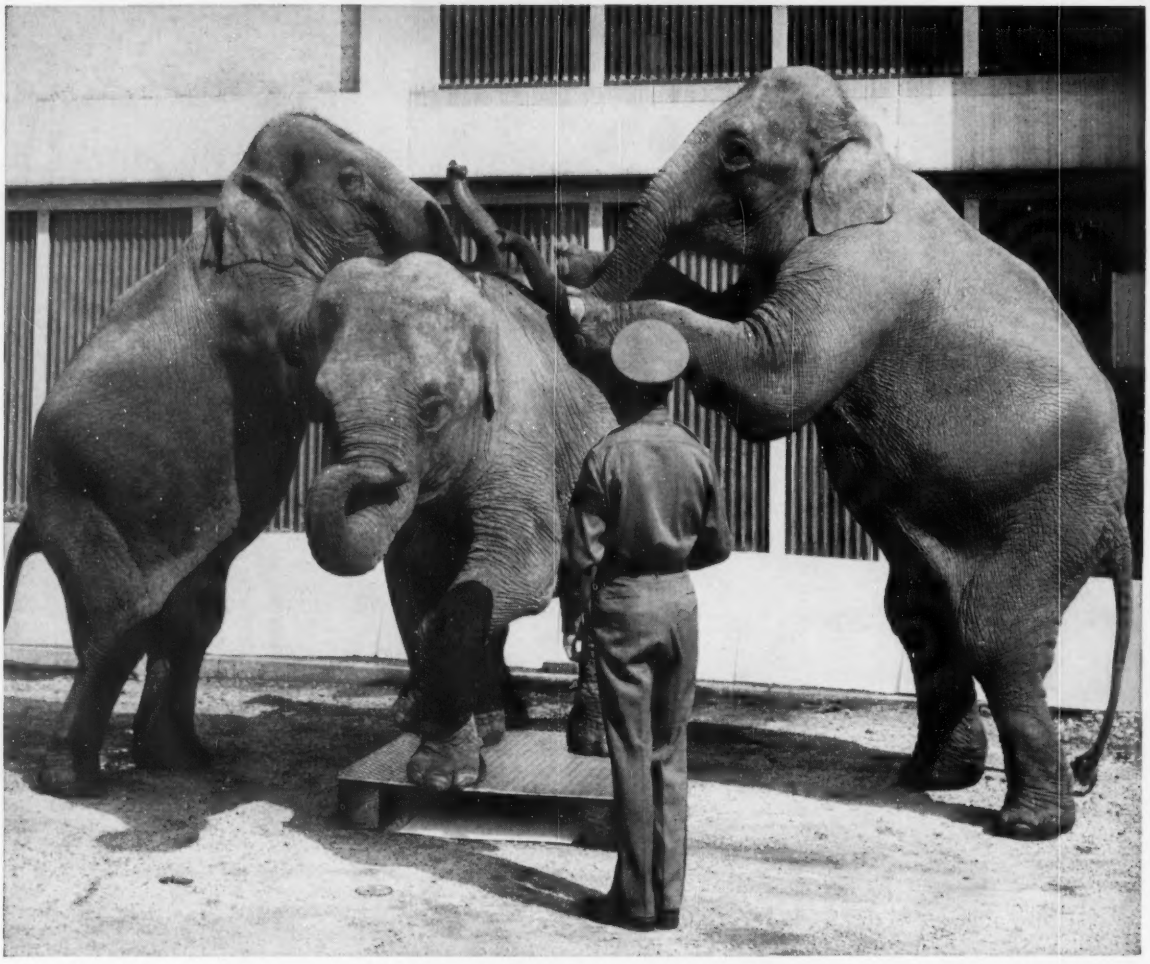
Breakers Increase Safety

In speed of restoring power, breaker advantages are obvious. A "tripped" breaker is immediately identified by the position of its handle. A quick flip of that handle restarts production in seconds. If a fault persists, the breaker reacts again to protect the circuit. It's all done with complete safety to the operator.

Fuse hunting, on the other hand, can be costly in accumulated man-machine-time. Locate the blown fuse . . . remove it . . . find the right replacement (still not as accurately calibrated as a breaker) . . . insert it . . . close switch. No matter how well organized your electrical maintenance crew, time is lost.

Unfortunately, the time clock does not stop ticking off the cost just because payload is cut off. Thus, the more complete your automation, the more important your need for real protection of its continuity with circuit breakers. J-30274

Circle 430 on page 19



2-TON BABIES PROVE 4-WAY'S STRUCTURAL STRENGTH

These frolicsome 2-ton circus babies demonstrate the ability of Inland 4-WAY Safety Plate to support tremendous weights. Because of 4-WAY's rugged strength, this 4′ x 4′ plate bears up under 4,000 pounds of pudgy pachyderm without a hint of strain.

The extreme structural strength of Inland 4-WAY Safety Plate is an important factor in plant safety. 4-WAY is not just another flooring surface material, but a steel plate that can be used as a structural member.

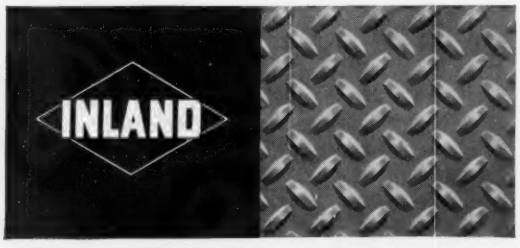
Strength, however, is only one of the advantages that 4-WAY offers. Its **slip-resistance, durability, attractive appearance, ease of application, fire resistance, ease of fabrication and cleanability** provide you with a combination of features unequalled by any other materials. Where can *you* use Inland 4-WAY Safety Plate? There are dozens of places in every plant where it can pay off in man hours saved . . . in providing safer, cleaner surfaces . . . in boosting general efficiency. For helpful suggestions and useful information, write to Dick Prendergast, Room 1262.

INLAND 4-WAY® SAFETY PLATE

INLAND STEEL COMPANY

38 South Dearborn Street • Chicago 3, Illinois

Sales Offices: Chicago • Milwaukee • St. Paul • Davenport
St. Louis • Kansas City • Indianapolis • Detroit • New York



Circle 431 on page 19

NEW

FAIRBANKS-MORSE

INTEGRAL HP

SINGLE PHASE

CAPACITOR

MOTORS

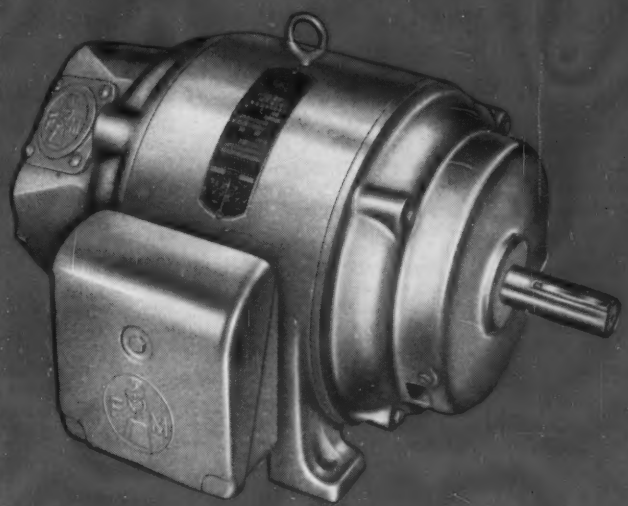
Newest addition to the F-M line of improved electrical equipment, single-phase capacitor-start motors are designed for severe applications.

New drip-proof frame and bearing arms are rigid, durable, corrosion-resistant. No pressed steel or sheet aluminum in any structural part. Famous F-M Copperspun rotor with shaft, fans and centrifugal switching mechanism dynamically balanced as a unit for smooth, vibrationless operation.

Starting capacitors are designed for maximum starting torque . . . minimum starting current. Rugged, trouble-free centrifugal switch features oversized snap-action contacts.

New Bulletin 2401 giving complete details will bring you up to date on the newest in capacitor-start, induction-run motors. Write: Fairbanks, Morse & Co., Dept. MD-103, Chicago 5, Illinois.

Circle 432 on page 19

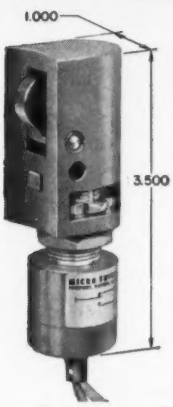


FAIRBANKS-MORSE

a name worth remembering when you want the BEST

ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • PUMPS • SCALES • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MAGNETOS

Switches have uses unlimited



NEW!

MICRO SWITCH "Rocket Switch"— a rugged, sealed small switch for indicating and lockout devices

Developed for use on rocket launchers, this MICRO SWITCH 21AS2 assembly fits the needs of many industrial designs.

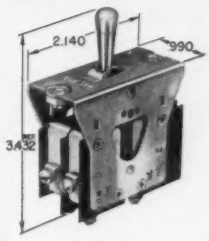
The assembly consists of one SPDT Type-EN switch attached to a rugged cam-type actuator. The assembly is environment-proof and withstands the highly-corrosive effects of rocket propulsion gases. The assembly will withstand heavy impact hammer blows on the actuator.

(Send for Data Sheet 120)

SWITCH CHARACTERISTICS

Operating force—6 to 12 lbs. Full overtravel force—10 lbs. min.; Release force—4 lbs. min.

Electrical Data: 28 vdc rating: inductive, 3 amps. at sea level and 2 amps. at 50,000 feet; resistive, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet. Motor, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet. (Altitude ratings established with seal deliberately broken.)



NEW!

MICRO SWITCH three-position toggle switch—4 SPDT circuits with a single lever

MICRO SWITCH 115AT Series of toggle switches uses four SPDT switching units. Two units are actuated in each extreme toggle lever position. None are actuated when lever is in center position.

Many different combinations, however, may be obtained, including the make and break of circuits in all three lever positions.

Outstanding features of this series include the compact design, positively-driven switch actuators and sturdy construction. A safety catch guards against accidental movement of toggle lever. *(Send for Data Sheet 132)*

SWITCH CHARACTERISTICS

Electrical rating at 30 vdc: inductive—10 amps. at sea level, 6 amps. at 50,000 ft.; resistive—10 amps.; motor—6 amps. Basic units listed by Underwriters' Laboratories for: 10 amps. 125 or 250 vac; ½ amp. 125 vdc; ¼ amp. 250 vdc.

NEW!

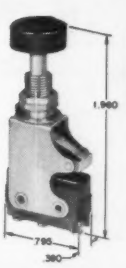
MICRO SWITCH completely sealed magnetic hold-in toggle switch

The MICRO SWITCH 5ET Series is a completely sealed momentary action toggle switch which also functions as a maintained contact switch. When the toggle lever is operated and a solenoid is energized, the magnetic force holds the lever operated. This hold-in feature permits remote electrical release of the lever.

Both switch and solenoid are sealed within the cylindrically shaped enclosure. This insures constant operating characteristics. An elastomer seal at the base of the toggle lever prevents entrance of dust or moisture. *(Send for Data Sheet 121)*

SWITCH CHARACTERISTICS

Total travel 30°; Contact arrangement SPDT, may be wired either N. O. or N. C. Electrical rating at 28 vdc: inductive, 3 amps. at sea level and 2.5 amps. at 50,000 feet; resistive, 4 amps. at sea level and 50,000 feet; motor, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet; Hold-in rating of solenoid is 18-30 volts dc.



NEW!

MICRO SWITCH "typewriter" pushbutton switch for manual keyboard control

MICRO SWITCH 1PB81-T2 switch is ideal for one-finger rapid-repeat operation such as is required for the type of keyboard control found in electric typewriters, adding machines, etc. The repeat action is as rapid as the fastest operator can push the button.

This switch uses a SPDT MICRO SWITCH subminiature switch for snap-action reliability. The contoured button and unique overtravel spring combine to reduce operator fatigue. Operating "feel," however, is sufficient to avoid mistakes and false actuations.

Removable ½ in. dia. plastic button is available in red, green, off-white or black. It is keyed to prevent rotation. *(Send for Data Sheet 125)*

SWITCH CHARACTERISTICS

Electrical rating at 30 vdc: inductive—3 amps. at sea level and 50,000 ft.; maximum inrush—15 amps. Basic subminiature switch is listed by Underwriters' Laboratories at 5 amps. 125 or 250 vac.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

Circle 433 on page 19

Experienced hands at solving many corrosion and heat problems

Your choice of over 35 analyses for
• corrosion resistance • heat resistance
• light-weight strength

AISI TYPES			SUPER CORROSION-RESISTANT TYPES
302	310	321	Carpenter Stainless No. 20Cb
304	316	347	Carpenter 7Mo
304L	316Cb	348	Carpenter Alloy B
309	316L	430	Carpenter Alloy C
309S	317	442	Titanium 55 and 70
309SCb	317L	443	

Other specialty grades in various stages of development are available: Zirconium, Zircalloy II, 19-9 DL, Invar, HiMu80, N-155, Haynes No. 25 (L-605), Hastelloy F and Hastelloy X, Armco 17-7PH, Titanium alloys, A-286 and others.

Here's why it will pay you to consult Carpenter about corrosion and heat-resistant tubing for pressure, mechanical, structural and sanitary requirements: The wide variety of types, grades, shapes, finishes and sizes illustrated can be supplied in the many standard and speciality analyses listed above. You benefit from over a quarter century of experience in helping equipment designers and builders solve a vast assortment of corrosion and heat problems. Carpenter's meticulous quality control assures you of getting tubing and pipe of the highest possible degree of perfection. Technical and metallurgical assistance with your materials selection and fabrication and nation-wide service on your requirements are available through qualified Carpenter Distributors and Representatives in over 40 cities.

Put your problems in Carpenter's capable hands today. Ask for Bulletin T.D. 120.

MEMBER STEEL FOUNDERS' SOCIETY OF AMERICA INSTITUTE

The Carpenter Steel Company
Alloy Tube Division, Union, N. J.

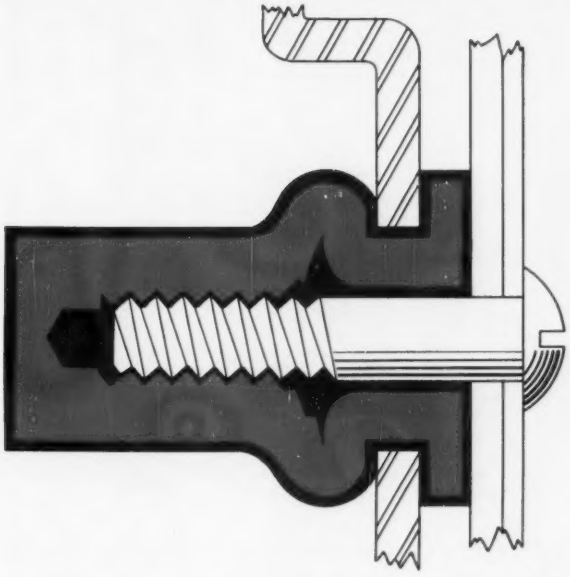
Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

more than corrosion resistance

Stainless Tubing & Pipe

B.F.Goodrich Rivnuts®
boost profits by cutting assembly costs



RIVNUTS PROVIDE 6 THREAD NUTPLATES THAT STAY PUT, ELIMINATE WELDING, SPEED ASSEMBLY

Suppose you have to fasten a porcelainized sheet metal top to a frame assembly. You want to do the job as quickly as possible to keep down your production costs. You also want to be able to remove the top easily for servicing.

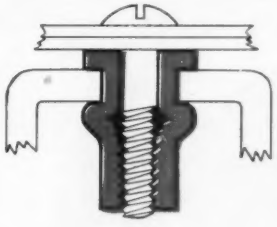
This is the problem that faced the manufacturer of automatic washing machines. He solved it by using Rivnuts, the *only* one-piece blind nutplate with threads. Upset from *one* side by *one* worker in seconds, Rivnuts provided a nutplate—solid as a rivet—with six clean threads for screw attachment. No matter how many times the top is removed, Rivnuts stay firmly in place with threads intact.

Before selecting Rivnuts, this manufacturer considered several conventional fastening methods. None of them appeared satisfactory. Bolts would hold the top, but the nuts would drop down inside if the top were removed. Self-tapping screw might tear loose. And the cost of installing welded nutplates was prohibitive—might have caused warping of the thin sheet metal.

By using Rivnuts, time was saved two ways: in factory assembly and in maintenance later on. B. F. Goodrich Rivnuts have speeded up thousands of similar operations and helped provide better, stronger products with greater eye appeal, beauty and sales appeal. No doubt they can do the same for you. Just write B. F. Goodrich Aviation Products outlining your problem. Our engineers will determine which Rivnut will do the job.

RIVNUTS SOLVE THE PROBLEM WHEN OTHER FASTENING METHODS FAIL

RIVNUTS

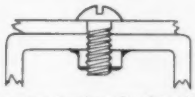


Installed from one side. Gives the strength of 6 clean threads. Provides firm, accurate nutplate. Installed in seconds by one person after enameling.

SELF-TAPPING

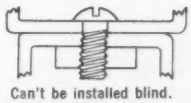
No structural strength. Tears loose easily. Lacks quality. Limits refastening.

WELDING



Requires tapping, cleaning, etc. Must be done before enameling. Gives fewer threads. Costs too much.

NUTS



Can't be installed blind. Drop down inside during removal. Difficult to install.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten *with* and *to*. Explains construction, simplicity of installation. Get your free copy by writing to: B. F. Goodrich Rivnuts, Department MD-107A, Akron, Ohio.

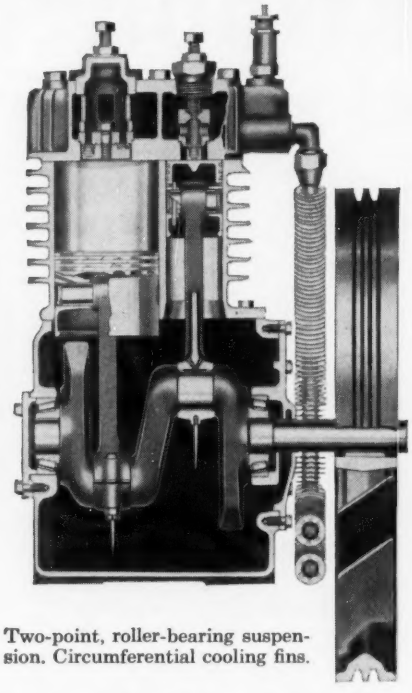
B.F.Goodrich

B.F.Goodrich Aviation Products

a division of The B. F. Goodrich Company, Akron, Ohio

Circle 435 on page 19

Model ACM vertical air-cooled compressor.



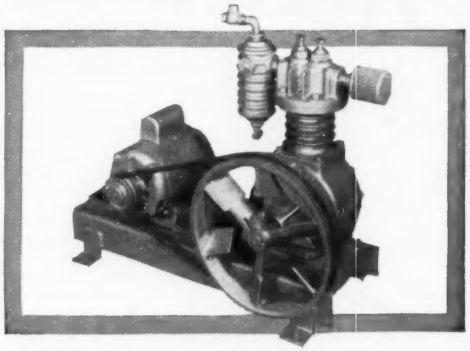
Two-point, roller-bearing suspension. Circumferential cooling fins.

There's assurance for designers in Gardner-Denver Air Compressors

When your specifications call for "built-in" air power, the installation of a Gardner-Denver compressor relieves you of concern about dependable operation.

Construction features of Gardner-Denver compressors, as shown in the cutaway view, tell the story of Gardner-Denver quality construction. Note that even in our smallest standard compressors, a *complete* crankshaft is used—supported on roller-bearing mountings on *both sides* of the throw. Note, also, the use of circumferential fins that dissipate heat evenly on all sides of the cylinder.

A complete line of Gardner-Denver compressors, both single and double stage, bare units or base mounted, permits the designer to select the right unit for the job. If our standard units should not meet design requirements, we will gladly work with you in designing special adaptations. Write for complete details.



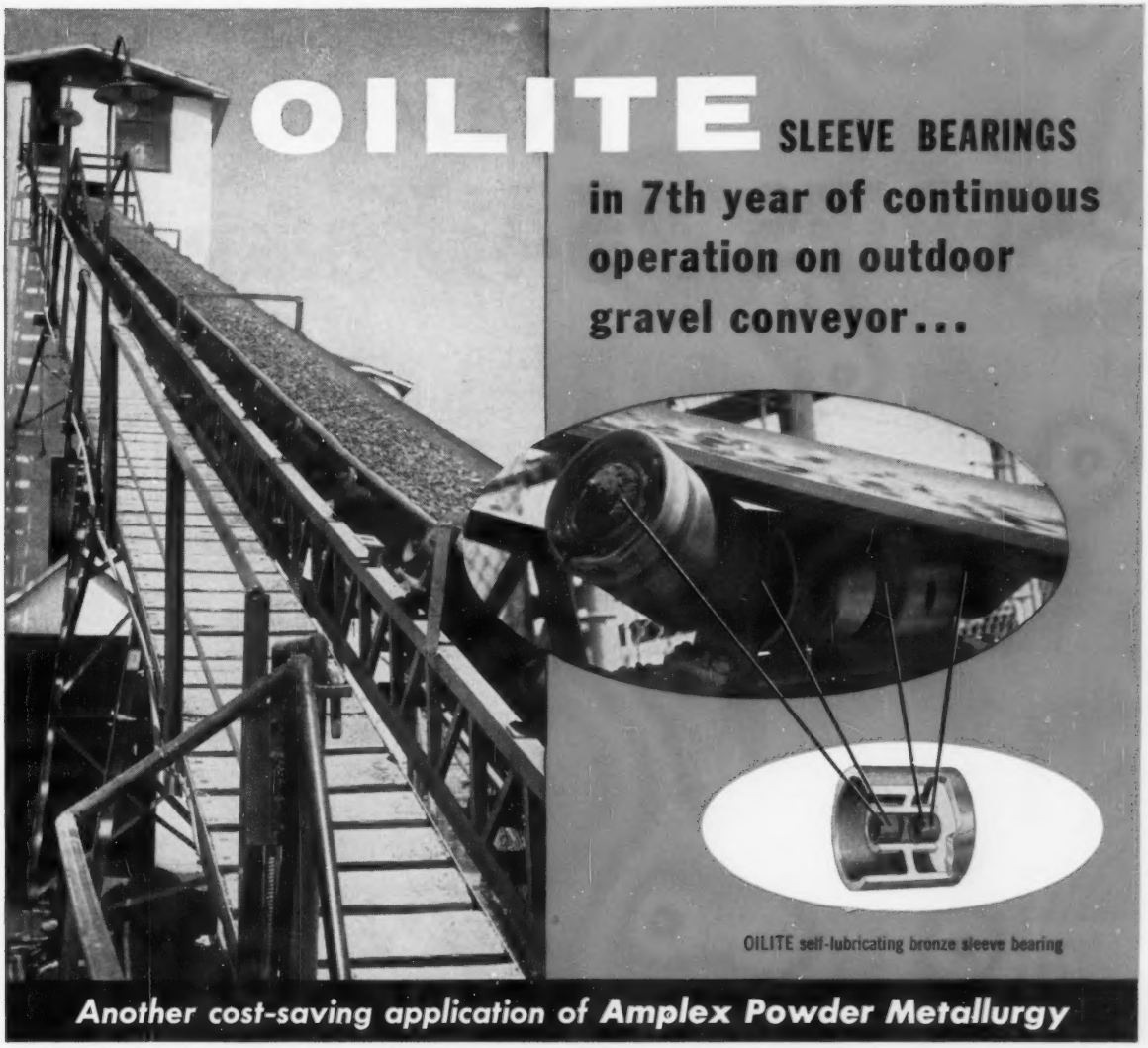
Oil-free air from small compressor. Gardner-Denver produced this new compressor for inclusion with equipment for food, brewery, distilling, instrument control, etc. Base or tank mounted. Supplies 4 to 5 cu. ft. of *oil-free* air per min. Requires no oil or water lubrication in cylinder because of carbon parts. Model CACB.

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

Circle 436 on page 19



No seals protect these OILITE bearings from sand, gravel, grit. On the two center rollers, no additional lubrication is possible. Yet this OILITE-equipped outdoor conveyor has been in continuous operation under extreme weather conditions for seven years—*without replacing one OILITE bearing.*

That's some record! J. Cooke (Concrete Blocks) Ltd., of Aldershot, Ontario, one of Canada's largest producers of concrete blocks, operating twenty of these sand and gravel conveyors, has proved the long wearing, money saving qualities of OILITE bearings. No wonder all twenty conveyors are 100% OILITE equipped. The company says, "We wouldn't use any other kind."

What interests you? Longer product life—greater efficiency—lower cost? All three? Maybe Amplex has the answer.

Write for detailed information about Amplex powder metal components—OILITE Bearings, Parts, Filters. Or call your nearest engineering representative listed in the yellow pages under "Bearings—OILITE."

A CHRYSLER OILITE® PRODUCT

*OILITE is a registered trademark

*Only Chrysler Makes Oilite**

AMPLEX DIVISION

CHRYSLER CORPORATION • DETROIT 31, MICHIGAN

Representatives and dealers located throughout the world

BEARINGS • FINISHED MACHINED PARTS • PERMANENT METAL FILTERS • FRICTION UNITS • FERROUS AND NON-FERROUS METALS

Circle 437 on page 19

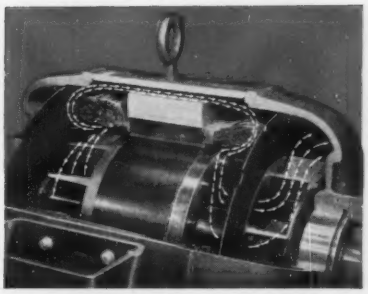
NEW ROBBINS "SERIES 254U" RE-RATED FIVE BIG

FULL HEIGHT END HEAD PROTECTION
One piece shrouded end heads give full height protection against moisture and falling objects. Internal baffles complete splash-proof construction.

& MYERS

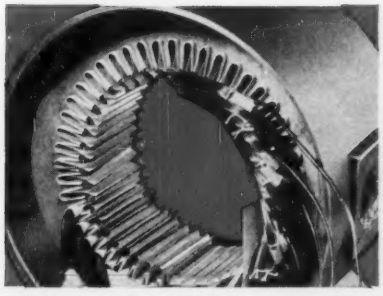
MOTORS offer you...

ADVANTAGES!



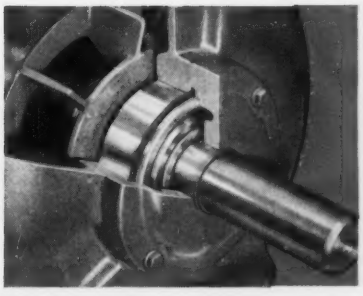
"STRAIGHT THROUGH" DUAL-SWEEP VENTILATION ELIMINATES "HOT SPOTS"

Tandem fans, one pushing and the other pulling, produce washing action around and over field coil ends, insure lower internal temperatures and longer dependable operation.



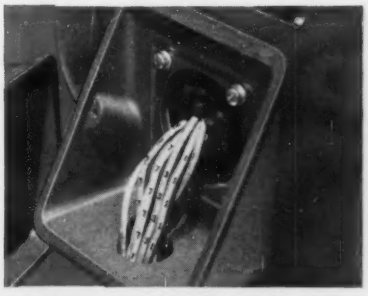
MYLAR* INSULATION INCREASES MOTOR LIFE. Mylar*, laminated to rag paper insures positive insulation and assures virtually permanent protection because of its excellent dielectric qualities. In addition, the rag paper backing provides a cushioning effect for added resistance to abrasions and punctures.

*DuPont registered trademark.



BEARINGS EASILY INSPECTED

Removable cover plate at each end of head permits easy bearing inspection without dismantling motor. Bearings run in double-width races, thus have extra-large reservoirs containing grease selected to resist dust, temperature, humidity and high operating speeds.



PERMANENTLY NUMBERED LEADS SIMPLIFY INSTALLATION AND MAINTENANCE

Proper lead identification is assured even after years of exposure. Numbers are permanently impregnated into the sub-surface of the insulation . . . can't wear off or deteriorate.

THESE five big advantages make R&M's "Series 254U" re-rated motors your best buy for applications requiring dependable, full-time performance. They can be installed in any environment, outdoors without a cover or in damp and corrosive atmospheres. Moisture, rust or corrosion can't affect their operation, and they take rugged duty in stride! Every R&M motor is electrically and mechanically designed to withstand the most severe operating conditions. Careful quality control and precision manufacture insure top performance and dependability year after year. Write today, for R&M Bulletin 520MD on R&M's "Series 254U" re-rated motors!

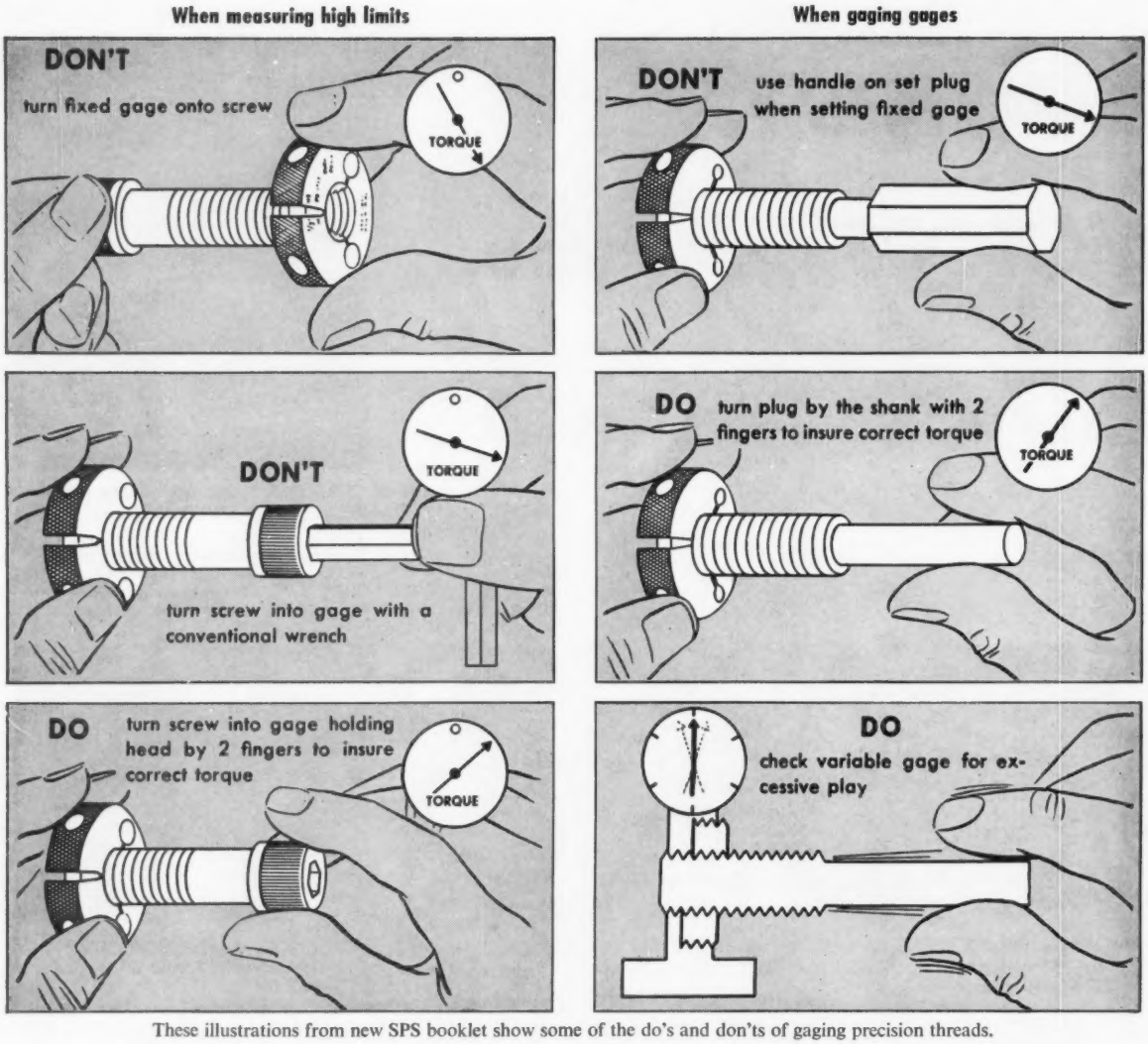
R&M

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO / BRANTFORD, ONTARIO

Motors Fans Hoists Moyno® Pumps Propellair® (Industrial) Fans

Circle 438 on page 19



These illustrations from new SPS booklet show some of the do's and don'ts of gaging precision threads.

3A threads: what they are; how to gage them – new SPS booklet tells all

Threads made to Class 3A fit are the most precise in general use in industry. But you do not always get the 3A precision you specify. Because of many different gaging techniques that yield varying results, screws with threads well outside the Class 3A tolerance limits often pass inspection.

SPS has prepared a new booklet on this subject. It explains clearly what Class 3A threads are and the pros and cons involved in the widely varying gaging techniques in use today. It reviews the gaging of high and low limits of 3A threads, sampling techniques, and even the methods of gaging gages.

All standard UNBRAKO socket screw products fall within specified tolerance limits *no matter what method is used to gage them.* Leading industrial distributors carry complete stocks. Unbrako Socket Screw Division, STANDARD PRESSED STEEL Co., Jenkintown 18, Pa.

We also manufacture precision titanium fasteners. Write for free booklet.

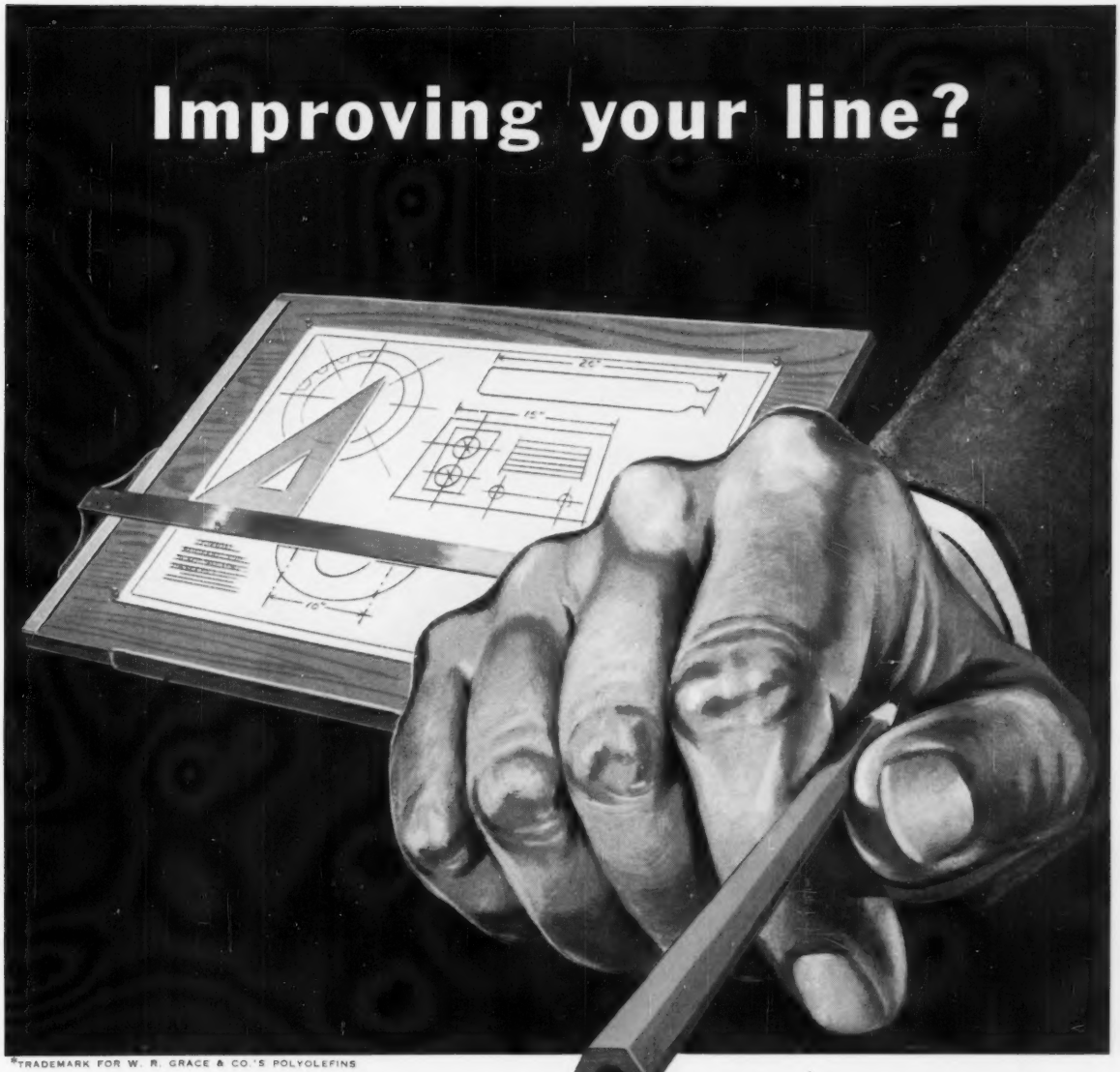
Form 2239, "Class 3A Threads: what they are; how to gage them." 16 pages, with many illustrations. Write for free copy today.

STANDARD PRESSED STEEL CO.

UNBRAKO® **SOCKET SCREW DIVISION** SPS

JENKINTOWN PENNSYLVANIA

Circle 439 on page 19



*TRADEMARK FOR W. R. GRACE & CO.'S POLYOLEFINS

It pays to check GREX*

It pays to check GREX . . . the newest in plastics . . . when manufacturing economy and product improvement are up for discussion.

GREX is true high density, high strength polyethylene. Its mechanical, chemical and electrical properties are significantly improved over many of today's most commonly used plastics.

GREX is recommended for plastic parts or objects destined for hard, prolonged usage, thanks to its high impact and tensile strength. GREX resists chemical attack, and can be used to contain corrosive acid. Highly resistant to heat, this new plastic can be boiled and sterilized, thus opening countless possibilities in the container, houseware, hospital and industrial fields. And its capacity for electrical insulation recommends GREX for the power and communications fields as well.

Until now, only the costliest plastics have offered these properties. GREX supplies them in *economical* form.

Tell us your plastic requirements . . . and we'll furnish full details and technical assistance to both you and your plastics molder.

W. R. GRACE & CO.
POLYMER CHEMICALS DIVISION

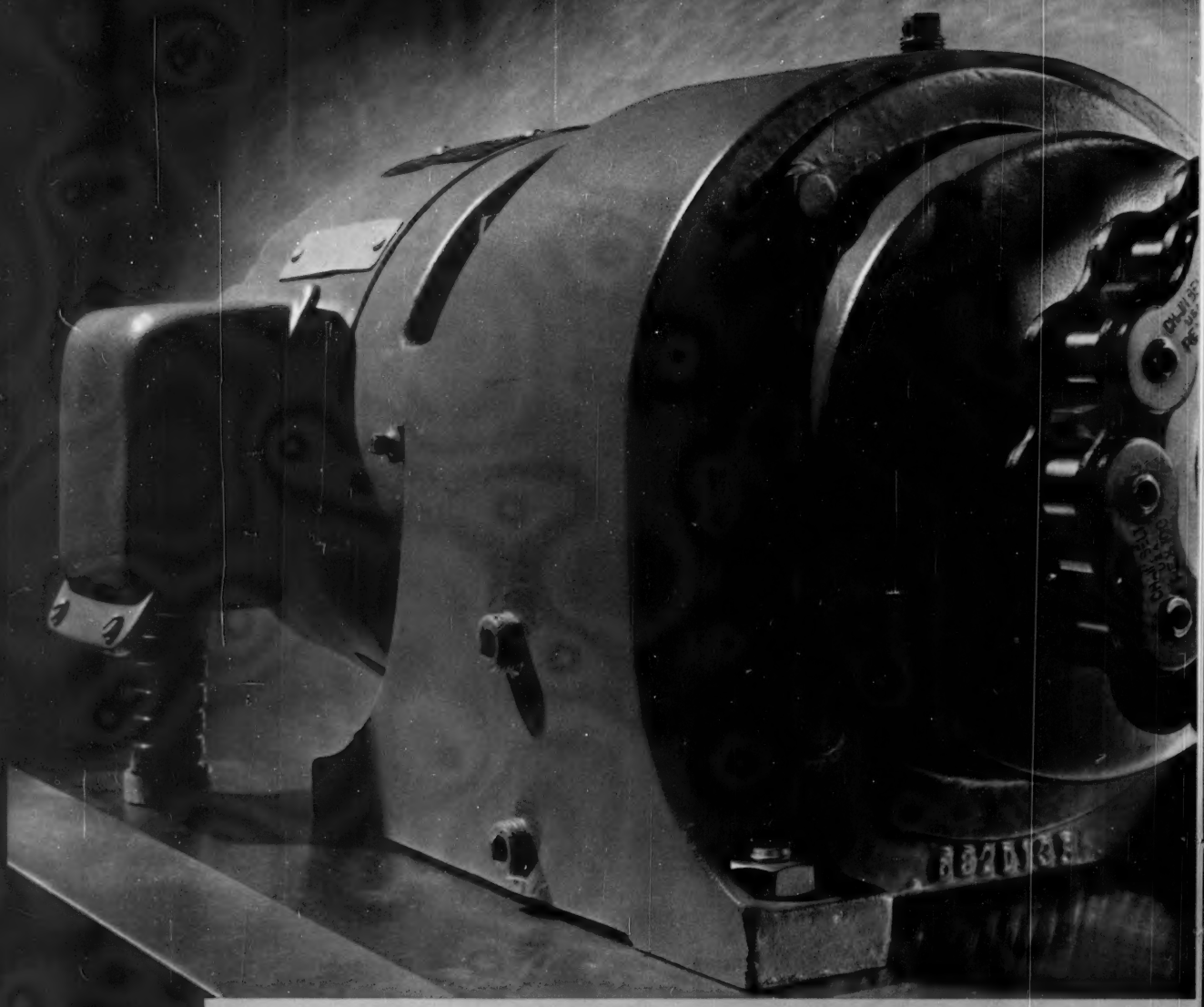
Plant
Baton Rouge, La.

Offices
Clifton, N. J.

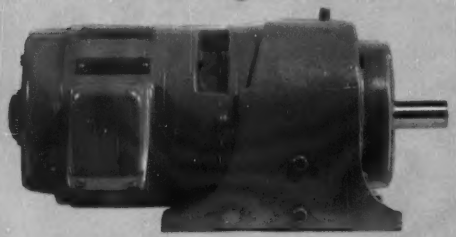
Circle 440 on page 19

Circle 441 on page 19→

A great gear-motor

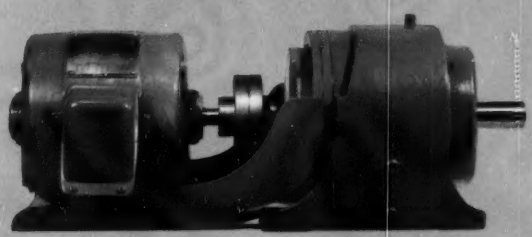


NEW integral unit



Compact, one-piece unit has complete, easily removable motor, machined-in alignment.

NEW all-motor unit



Providing wide application flexibility, motor change may be accomplished without disturbing gear.

General Electric's

NEW

gear-motor line

Now, you can meet all your low-speed drive requirements from a brand new line of General Electric packaged power transmissions. This 3-unit line is based on a new, completely simplified, helical design that has evolved from General Electric's 25 years of gear-motor engineering and application experience. And it's a line that can provide you with important, 3-way savings on all low-speed applications.

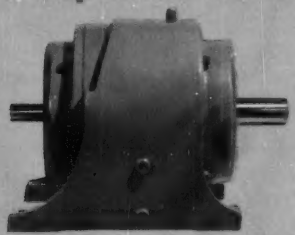
1. Greater reliability: This new line incorporates the most advanced gear manufacturing methods and all units are factory tested before shipment. In addition, you benefit because you purchase both motors and gears from a single manufacturer.

2. Easier Maintenance: A cinch to assemble and disassemble, alignment is machined right into each unit. Gear components may be carried in stock as sub-assemblies, minimizing downtime for normal repair.

3. Reduced inventory: You can reduce your inventory with no sacrifice to your operating continuity. Parts standardization and interchangeability permit a basically lower inventory investment.

This new line was developed to keep pace with the new requirements and wider applications of gear-motors brought about by advanced manufacturing techniques. *Get complete information from your nearest Apparatus Sales Office or Distributor—or write for bulletin GEA-6704, containing line highlights, to General Electric Co., section 851-6, Schenectady, N. Y.* Gear-Motor and Transmission Components Dept.

NEW separate reducer



Unit can provide a variety of output speeds with change of belt or chain rates.

Progress Is Our Most Important Product

GENERAL ELECTRIC

when should you pay $13.00* a pound for TITANIUM?

The answer is *when its cost/life ratio makes titanium less costly than other metals*—as it often does. Look at it this way . . .

More Metal Per Pound—Titanium weighs only 56% as much as steel of the same strength. Where 50 pounds of steel is needed—28 pounds of titanium will do the job.

It's Final Cost That Counts—Fabricating takes the lion's share of production costs on most jobs. Considering material and fabricating costs together usually whittles down the titanium price differential to 2 or 3 to 1. And, most important . . .

Titanium Outlasts Most Metals—even those generally considered 'corrosion-resistant,' by 10, 20, even 50 times or more.

Added together, these facts often make titanium the most inexpensive material you can use. And only titanium can provide its exceptional combination of *light-weight, high-strength,* and *resistance to corrosion.* Ask a REM-CRU engineer to give you complete details about what titanium can do for you.

**The actual cost of titanium mill products varies with the grade, size and quantity ordered. The $13.00 figure is representative of today's prices for items used in commercial applications.*

Write Dept. MD10 for the Rem-Cru Review—a free periodical presenting the latest data on titanium.

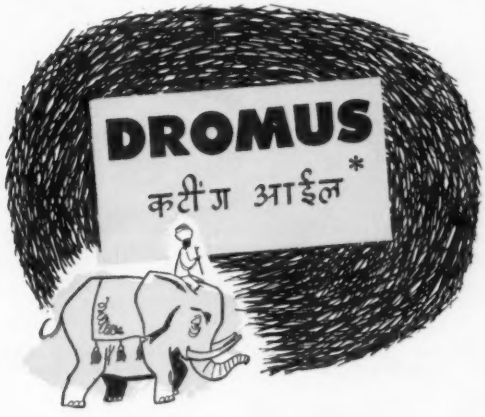
REM-CRU TITANIUM

World's Most Versatile Metal

MIDLAND, PENNSYLVANIA

Sales Offices: 6033 East Bandini Boulevard, Los Angeles 22, California • 4501 W. Cortland Street, Chicago 39, Illinois • 405 Lexington Avenue, New York 17, N. Y.

No matter how you say it...



*TRANSLATION: CUTTING OIL

The performance and the brand are the same around the world

Other Outstanding Shell Industrial Lubricants

Shell Tellus Oil—for closed hydraulic systems

Shell Alvania Grease—multi-purpose industrial lubricant

Shell Turbo Oil—for utility, industrial & marine turbines

Shell Rimula Oil—for heavy-duty diesel engines

Shell Talona R Oil 40—anti-wear crankcase oil for diesel locomotives

Shell Dromus Oils, a quality line of soluble cutting oils, permit higher speeds and greater feeds while extending tool life. They have excellent wetting and cooling properties and are not sticky or greasy.

Dromus® Oils have the added advantage of being easy to mix in hot or cold, hard or soft water. They form emulsions which remain stable in practically any concentration required in the shop.

Today Dromus Oils are available to your customers abroad. You can be sure that they will enjoy the same efficient performance your domestic customers rely upon.

• • •

For more information, write Shell Oil Company, 50 West 50th Street, New York 20, N. Y., or 100 Bush Street, San Francisco 6, California.

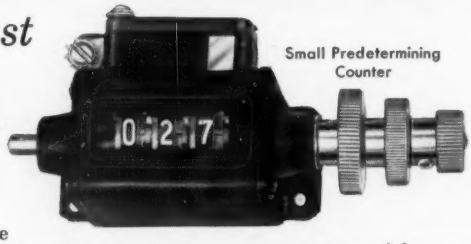
SHELL DROMUS OILS

SHELL

Circle 443 on page 19

Here's why it pays to CALL FOR HELP

. . . first thing instead of last



Small Predetermining Counter

If you want to do anything "by the numbers," first thing to do is call the No. 1 man . . . your Veeder-Root District Engineer. Because he's an *original thinker* like yourself when it comes to designing or building *Count*rol into any type of product or process.

He knows his book on the most complete line of standard electrical, mechanical and manual counters made anywhere in the world. And from this line he can very likely adapt or modify a standard counter to your special needs. This saves cost and time in engineering, purchasing, assembly.

And you get a lot of new user-benefits to merchandise . . . direct readings, rather than dials and scales . . . remote indication from plant to office if needed . . . production figures that serve as a fair base for wage and incentive payments, production and stock *Count*rol, tax computation . . . and as proof of your own performance guarantee. So call the V-R man in, *when you begin* . . . look him up in your local phone book, or write direct to:

VEEDER-ROOT INC., Hartford 2, Connecticut

Added Evidence that . . .

Everyone Can Count on VEEDER-ROOT

Hartford, Conn. • Greenville, S. C. • Chicago • New York • Los Angeles • San Francisco • Montreal • *Offices and Agents in Principal Cities*

Circle 444 on page 19

FOR MORE EFFICIENT PRODUCTION—

ACTUATE OR POSITION IT BETTER WITH

SAGINAW b/b SCREWS

6 decisive advantages reduce manufacturing problems and costs:

FORWARD: When rotary motion is applied to the screw, the b/b nut is driven along the axis of the screw, changing rotary motion to linear motion.

FORWARD: When rotary motion is applied to the b/b nut, the screw is driven along its longitudinal axis, changing rotary motion to linear motion.

1 **POWER SAVINGS.** Operating with over 90% efficiency, Saginaw b/b Screws permit much smaller motors with far less drain on electrical systems, and also simplify circuitry.

2 **SPACE SAVINGS.** Saginaw b/b Screws themselves are compact. They permit smaller motors and gear boxes and eliminate auxiliary equipment required by hydraulics.

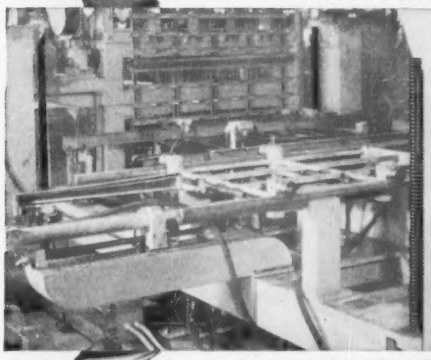
3 **DEPENDABLE PERFORMANCE.** Saginaw b/b Screws are far more reliable than hydraulics or pneumatics. Gothic-arch grooves, yoke deflectors and multiple circuits provide added assurance.

4 **PRECISE POSITIONING.** Saginaw b/b Screws will position components far more precisely than hydraulics or pneumatics; tolerances on position are held within .0006 in./ft. of travel.

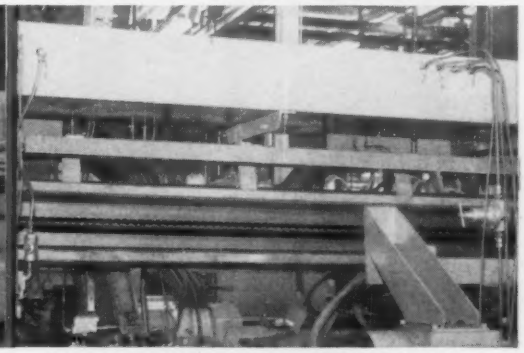
5 **TEMPERATURE TOLERANCE.** Normal operating temperature for Saginaw b/b Screws is from −75°F. to +275°F. But in selected materials, they will function efficiently at temperatures as high as +900°F.

6 **LUBRICATION.** If lubrication fails the Saginaw b/b Screw will still function with remarkable efficiency. Units have been built and qualified for operation without lubrication.

TYPICAL AUTOMATION APPLICATIONS



Automatic indexing device for stacking material. Saginaw b/b Screw used to raise and lower table.



Automatic device for loading and unloading machine. Saginaw b/b Screw used to save power and space.

If you would like further details on the use of Saginaw b/b Screws to increase the efficiency of plant operations, or specific application recommendations for your individual processes, experienced Saginaw engineers are at your service without obligation. Just write or phone us your requirements, or fill in and mail the handy coupon below.

Saginaw

ball bearing Screw

SAGINAW STEERING GEAR DIVISION OF GENERAL MOTORS • SAGINAW, MICHIGAN

WORLD'S LARGEST PRODUCER OF BALL BEARING SCREWS AND SPLINES

SEND TODAY FOR FREE 36-PAGE ENGINEERING DATA BOOK . . .

or see our section in Sweet's Product Design File

Saginaw Steering Gear Division
General Motors Corporation
b/b Screw and Spline Operation
Dept. 1H, Saginaw, Michigan

Please send new engineering data book on Saginaw b/b Screws and Splines to:

NAME _____

COMPANY _____ TITLE _____

ADDRESS _____

CITY _____ ZONE ____ STATE _____

Circle 445 on page 19

Circle 446 on page 19

UNMATCHED FOR POSITIVE HIGH PRESSURE CONTROL

ERMETO®

HYDRAULIC TUBE FITTINGS

ERMETO 8000 SERIES

Steel or stainless steel fittings in sizes and types to meet any need. No flaring, threading, welding or soldering.

ERMETO 7000 SERIES

Meets new S.A.E. Boss Specifications. Permits closer couplings, higher pressures. Weathercote finish resists corrosive elements.

Introduced by Weatherhead nearly a quarter century ago, Ermeto continues to top the list as industry's most popular high pressure flareless tube fitting. Assures better service in every field where hydraulic power is applied. Distributors coast to coast.

WEATHERHEAD

FIRST IN HYDRAULIC CONNECTIONS
THE WEATHERHEAD CO., FORT WAYNE DIVISION
Dept. AB-10, 128 West Washington Blvd., Fort Wayne, Indiana
In Canada: The Weatherhead Co., Ltd., St. Thomas, Ontario

Circle 447 on page 19

When selecting a timer— design for availability

Specifying one of the many standard units offered saves you and your customers time, money

Several distinct advantages accrue when you design for a standard timer—as against making a special timer for your specific job:

Cost is lower because no engineering or tooling charges are encountered. Service is quicker and easier. Replacement is simplified. Complete descriptive information and operating instructions are in print.

STOCK TIMERS FOR QUICK DELIVERY. But probably the most important single reason for sticking to standards is ready availability. Quantities of the exact type, range and rating can usually be obtained immediately from manufacturer's stock for prototype or test purposes. Production quantities can be supplied with minimum lead time because design has been completed, parts inventories established and assembly techniques perfected.

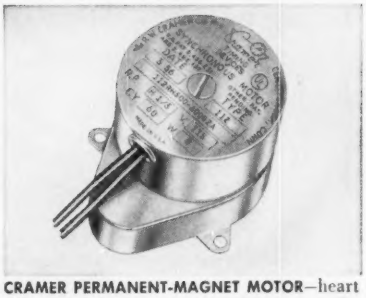
EXTREME VARIETY AVAILABLE. Leading timer manufacturers offer extremely wide lines of standard interval timers, time delay relays, cycling timers and time totalizers. In addition, a wide selection is offered within these groups. You can, for instance, pick a standard interval, cycling or delay timer to optimize almost any characteristic needed for your design; cost, mounting, accuracy, actuating means, and degree of adjustability. Each of these sub-categories in turn provides various time ranges, control arrangements and voltage-frequency combinations.

MINOR CHANGES EASY. In the event you can not find a stock or catalogued timer to meet your exact needs, discuss your problem with a full-line timer manufacturer. He will frequently be able to modify a similar unit to your specifications with only minor changes, thus saving you the costs of engineering and lengthy testing.

Only rarely will you have to specify a completely new design. And then your best approach is to talk it over with the specialists in the field of time control.

WRITE TIMER SPECS EARLY. Timer requirements should be determined early in the design process, so that an available standard timer, with the right characteristics and proved performance, can be accommodated.

LET US HELP YOU. Cramer engineers are always ready to discuss your time control problems. They can tell you about interval timers, time delay relays, cycling timers and time totalizers in 85 stock variations in the wide Cramer line. And they can handle your special needs, too. Write us or see your local Cramer representative. The Cramer Controls Corporation, Box 6, Centerbrook, Conn.



CRAMER PERMANENT-MAGNET MOTOR—heart of Cramer a-c timers. Available separately. Features fast start, truly synchronous operation, no coasting. *STOCKED* in many speeds, right or left rotation. Various output shafts. Torque: 30 in-oz at 1 rpm. Bulletin PB-110A.

A FEW STOCK TIMERS FROM THE BROAD CRAMER LINE

1. TYPE 631E TIME TOTALIZER. Registers elapsed time on 5-digit drum-type counter. *STOCKED* in total ranges of 9999.9 and 99999 hours at 115V, 60 cps. Also 9999.9 hours at 220V, 60 cps. Other available (including resettable) types count 1/10 seconds, seconds, 1/100 and 1/10 minutes, minutes, 1/10 hours and hours. Bulletin PB-610.

2. NEW TYPE 412 TIME DELAY RELAY. Introduces timed delay between operation of control circuit and load circuit. *STOCKED* in full-scale ranges of 6, 15, 30, 60, 120 seconds; 5, 15, 30, 60 minutes; 5, 12, 24 hours at 115V, 60 cps. Also 15, 60 seconds; 5, 15, 60 minutes at 220V, 60 cps. Bulletin PB-311.

3. NEW TYPE 241 AUTOMATIC RESET INTERVAL TIMER. Provides pushbutton start, automatic and immediate reset for electrically operated equipment. *STOCKED* in full-scale ranges of 6, 15, 30, 60, 120 seconds; 5, 15, 30, 60 minutes; 5, 12, 24 hours at 115V, 60 cps. Also 60 seconds; 5, 15, 60 minutes at 220V, 60 cps. Bulletin PB-241.

4. TYPE 610 PERCENTAGE TIMER. Makes (or breaks) electrical circuit for adjustable percentage of a fixed time period. Calibrated in steps of 1% from 4 through 96. 100% setting provided. Snap action switch. *STOCKED* in ranges of 15, 30, 60 seconds; 5 minutes at 115V, 60 cps. 15, 30, 60 seconds at 220V, 60 cps. Bulletin PB-510A.

TALK IT OVER WITH CRAMER

CRAMER CONTROLS
CORPORATION
(Formerly R. W. Cramer Co.)

6.16

Circle 448 on page 19

When you design for SOCKET SCREWS

. . . you don't need anything else!

Provides more pertinent data than you can find in a Catalog!

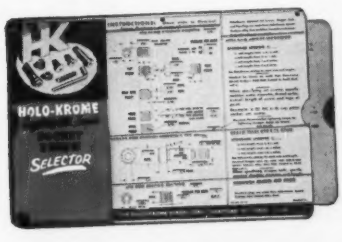
IT QUICKLY GIVES YOU:

DIAMETERS • PHYSICALS • TORQUE

STANDARD LENGTHS • STANDARD POINTS

ALL PERTINENT DIMENSIONAL AND PHYSICAL DATA

In the past two years, thousands of design engineers have written us requesting this H-K Selector. They know the H-K Selector is a valuable tool designed by engineers *for* engineers. When you need information at your fingertips to select the proper size and type of socket screw, you'll find the H-K Selector as handy as your slide rule. *It's yours free for the asking!*



Another Holo-Krome service feature—along with SAME-DAY SERVICE on catalog items, SAME-DAY INQUIRY SERVICE, SPECIALS shipped in 4 weeks or sooner!

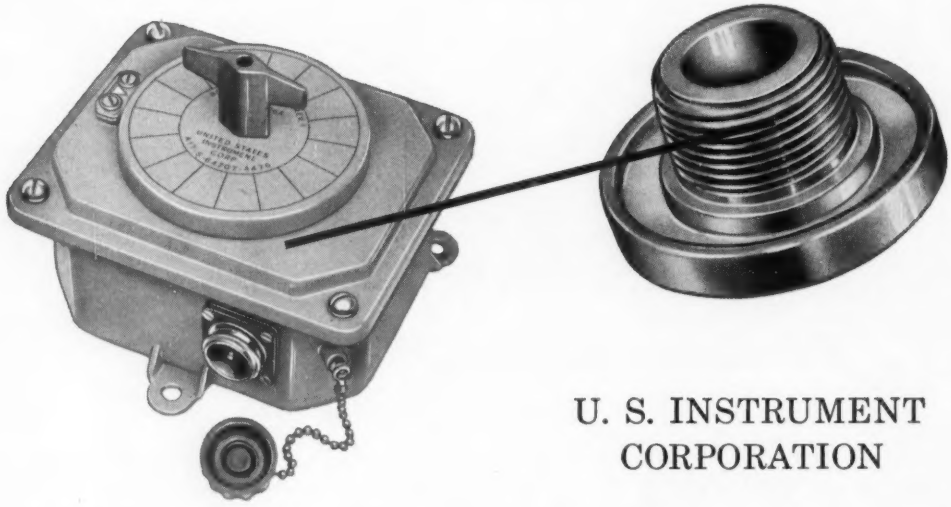
HOLO-KROME
Completely Cold Forged
SOCKET SCREWS

THE HOLO-KROME SCREW CORP.
HARTFORD 10, CONN.

Circle 449 on page 19

Three more nationally known manufacturers select Mueller Brass Co. Forgeable Bearing Alloys for vital components of their products

In ever-increasing numbers, Mueller Brass Co. specialized alloys are being specified by manufacturers of top-quality products. In a series of continuing advertisements, we have presented case histories of successful applications, to which we now add three more distinguished companies who are incorporating Mueller Brass Co. forgeable bearing alloys in their products to meet the demands of widely divergent operating conditions.



U. S. INSTRUMENT CORPORATION

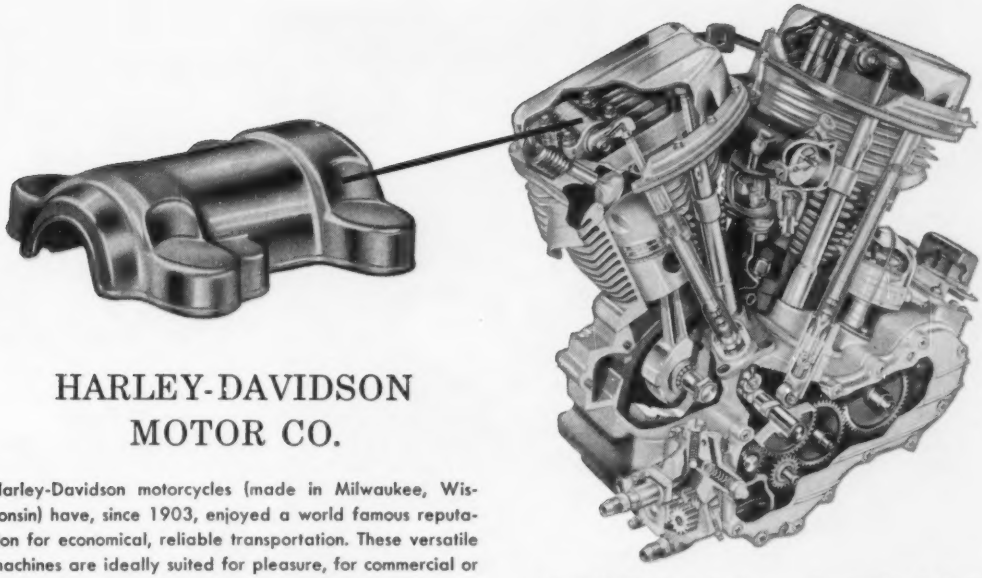
U. S. Instrument Corporation, Charlottesville, Va., selected abrasive-resistant Mueller bronze alloy bushings for their remarkable telephone selector switches after exhaustive tests of many materials. A vital communications link on today's U. S. Naval vessels, these sound-powered telephone circuits must meet rigid Navy performance-standards. Such phones, for example, must have selector switches which are capable of rotating for a minimum of 50,000 torturous cycles . . . 360° clockwise, followed by 360° counter-clockwise. In addition, the "O" ring must still form a water-tight seal AT THE END OF THE TEST! Of the many tested, a Mueller Brass Co. special manganese bronze alloy was the best one meeting these rigid specifications.

There were other important reasons why these bushings were chosen by U. S. Instrument Corporation for this application. Resistance to abrasive action against the rubber "O" ring was a prime one . . . then, too, the stem assembly suffered severe pounding through the action of the indexing mechanism which, prior to the use of the Mueller Brass Co. alloy, caused repeated seizure of the component parts. In this particular application, the part was fabricated on an automatic screw machine rather than produced as a forging. The versatility of Mueller Brass Co. alloys makes them readily adaptable to the most economical method of fabrication dependent upon the size, shape, and end-use requirements of the part.

In commenting on the success of this part, U. S. Instrument Corporation praised the alloy for its tensile strength (ordinary brasses could not withstand the 2000 ft. lb. impacts without deformation), for its machinability and corrosion-resistance.

40 MUELLER BRASS CO. 1917-1957

MUELLER BRASS CO.



HARLEY-DAVIDSON MOTOR CO.

Harley-Davidson motorcycles (made in Milwaukee, Wisconsin) have, since 1903, enjoyed a world famous reputation for economical, reliable transportation. These versatile machines are ideally suited for pleasure, for commercial or business use, as well as the grueling demands of law enforcement work. Harley-Davidsons boast a dependable engine . . . one which can roll up an astounding mileage record with little or no care. The painstaking selection of every engine component is one important reason for this reliability. The new twin-cylinder Harley-Davidson 74 OHV employs Mueller Brass Co. bronze alloy forgings in the form of rocker-arm bearing caps. Subjected to violent temperature changes, fast starts and stops and road shock, Mueller forgings are proving again and again that they have the ability necessary to withstand almost any punishment . . . and still provide unfailing service.

JACOBSEN MFG. CO.

Jacobsen Mfg. Co., Racine, Wisconsin, was among the first to produce a practical power mower for home use. That was more than 35 years ago! Today, Jacobsen power-mower dependability is evident itself in more than a dozen gleaming new models such as the popular Pacer, Lawn Queen, Manor and others. One of the most reliable components in the always dependable Jacobsen hi-torque engine is a Mueller Brass Co. connecting rod forged from special bronze alloy. Jacobsen mowers with Mueller-forged connecting rods are called upon by some commercial users to operate as much as 8 hours daily, 6 days a week . . . perhaps as much as 2000 hours a year. In searing summer temperatures, thru hours of constant operation, the high uniform strength of Mueller bronze forgings constantly withstands pounding and vibration with the same conspicuous success as in its many other applications.

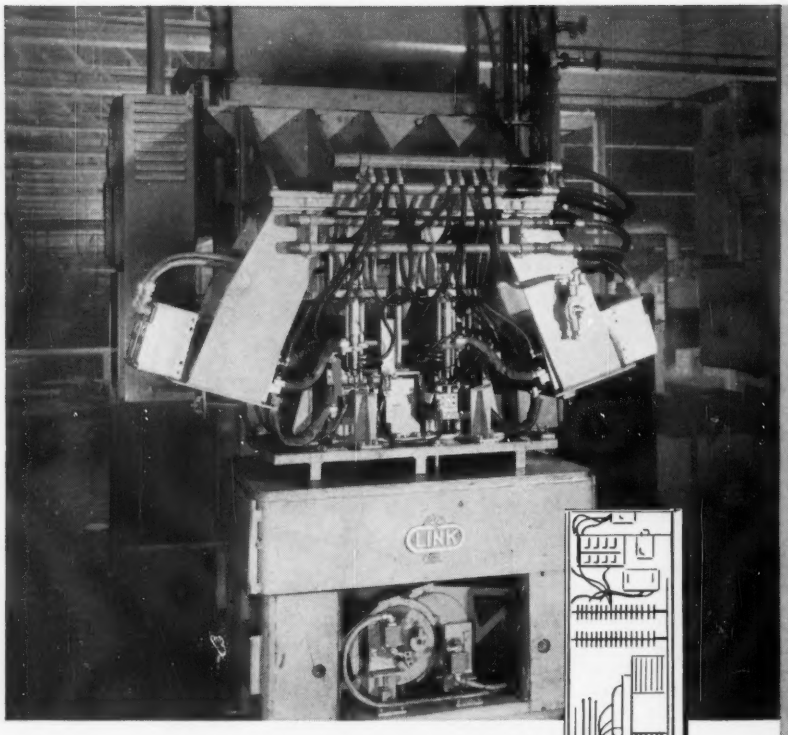
Why not investigate these specialized alloys for your own products. We welcome your inquiries. Our engineering staff will be happy to make specific recommendations. Both on the proper alloy and the best method of fabrication to meet your needs . . . exactly. Our engineering manuals show many, many examples of how American manufacturers have used these alloys to great advantage.

• WRITE TODAY FOR THE ENGINEERING MANUAL YOU NEED

- **Mueller Brass Co. Forgings** Engineering Manual H-58565 ☐
- **Tuf Stuf Aluminum Bronze Alloys** Engineering Manual H-58563 ☐
- **"600" Series Bearing Alloys** Engineering Manual FM-3000 ☐
- **Copper Base Alloys in Rod Form** Engineering Manual FM-3010 ☐

227

PORT HURON 20, MICHIGAN



DynAC®
stops welding table over 28,000 times per day!

Six hundred complete welding operations per hour, twenty-four hours a day, without the costly maintenance and wear of mechanical braking. That's the kind of record-breaking performance made possible with Westinghouse DYNAC.

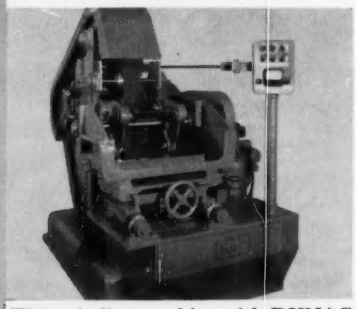
DYNAC on this automatic welder provides braking action for the welding table, stops it in exact position for welding or loading. Each operation requires the motor to start and stop twice . . . twenty stops per minute—28,000 per day!

DYNAC provides smoother, faster stops . . . boosts production. Completely electrical, DYNAC can be installed simply and quickly, anywhere—at machine or for remote operation.

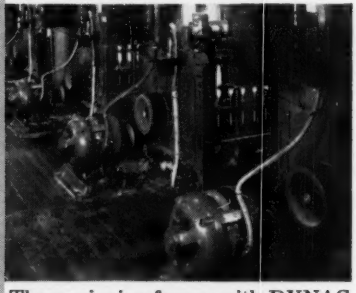
For the complete DYNAC story, call your local Westinghouse distributor or office . . . or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-22035

YOU CAN BE SURE . . . IF IT'S Westinghouse

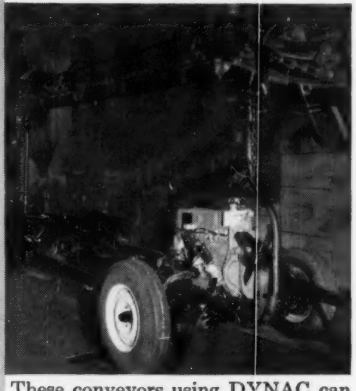
HERE ARE SOME TYPICAL DynAC APPLICATIONS:



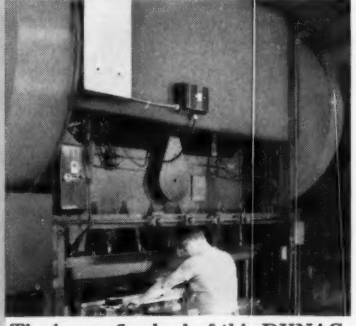
This grinding machine with DYNAC produces more finished pieces because of a faster work cycle.



These spinning frames with DYNAC have saved textile producers over $3,000 per year per 100 frames.



These conveyors using DYNAC can be stopped once a minute, day in and day out, without any maintenance.

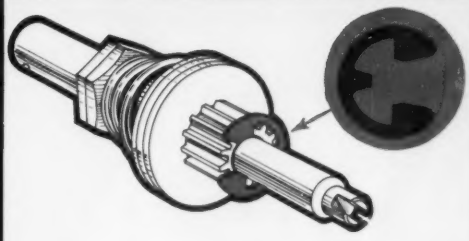


The heavy flywheel of this DYNAC-equipped stamping press can be stopped in just 24 seconds . . . former stopping time was a full eight minutes.

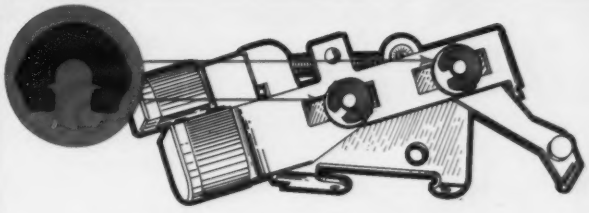
Waldes Truarc Rings speed assembly, facilitate maintenance, improve performance of new automatic calculator

THE NEW MARCHANT DECI•MAGIC
automatic-decimals calculator made by Marchant Calculators, Inc., Oakland, California.

CRESCENT RING SPEEDS ASSEMBLY, DISASSEMBLY
Main clutch utilizes radially-installed series 5103 crescent ring for rapid assembly and disassembly. Ring's low protruding shoulder provides necessary clearance between ring and the two studs. The main clutch operates each time a Deci-Magic control key is depressed.



E-RING SECURES PARTS AGAINST SPRING THRUST. Slip clutch assembly uses Truarc series 5133 E-ring to hold parts on shaft. Functioning of the assembly is dependent upon the ring's ability to withstand thrust exerted by the heavy barrel spring.



LOCKING PRONG RINGS PERMIT SIMPLE DESIGN. Shift slide assembly uses two Truarc series 5139 bowed locking prong rings to lock the parts together in a sliding fit. Precise amount of spring tension prevents objectionable wobble and noise, permits the key to slide smoothly in operation. Easy radial assembly and disassembly of rings facilitates field maintenance and repair. Alternative construction would have required cut washer, spring washer and hairpin-type spring clip on each stud.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Controlled Quality from engineering and raw materials through to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

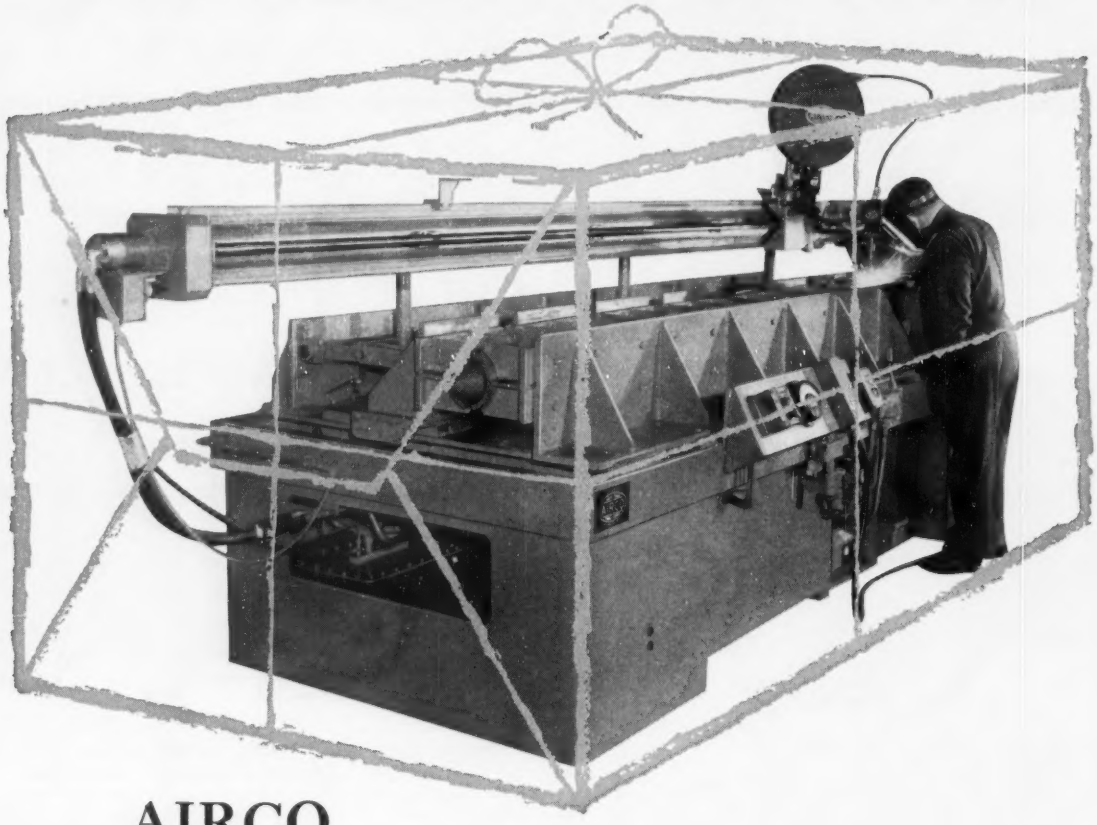
WALDES
TRUARC®
RETAINING RINGS
WALDES KOHINOOR, INC.
47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications. *(Please print)*

Name .....
Title .....
Company .....
Business Address .....
City ..... Zone ..... State .....
MD109

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

Manufacturer of heat treating equipment using an Airco machine welding installation to fabricate all-sheet alloy radiant furnace tubes used in annealing furnaces. The "package" includes all welding equipment, fixtures and controls tailored to specifications to produce welds automatically of the size, quality, type and speed required.



AIRCO PACKAGED MACHINE WELDING

Airco's Machine Welding Department can relieve you of many of the problems involved in installing an automatic welding operation in your plant. This welding-and-engineering service custom engineers automatic welding operations to your product design. Airco designs, constructs and installs all welding machine tools. Airco selects the most suitable welding equipment for the job, supervises installation, works out "bugs," and trains your employees in the operation of the equipment. You get a completely engineered "package."

Airco accepts full responsibility until the system is operating to your complete satisfaction. Airco's Machine Welding Department has already completed over 36 projects covering a wide range of automatic welding operations. For more information, write to J. H. Berryman, Machine Welding Department, at the address below.

AT THE FRONTIERS OF PROGRESS YOU'LL FIND . . .

AIRCO

Offices and dealers in most principal cities

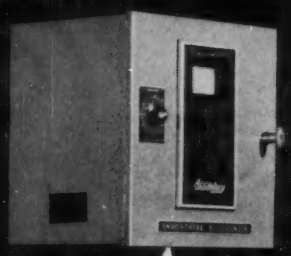
AIR REDUCTION SALES COMPANY

A division of Air Reduction Company, Incorporated
150 East 42nd Street, New York 17, N. Y.

On the west coast — Air Reduction Pacific Company
Internationally — Airco Company International
In Cuba — Cuban Air Products Corporation
In Canada — Air Reduction Canada Limited

Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** — industrial gases, welding and cutting equipment, and acetylenic chemicals • **PURECO** — carbon dioxide — gaseous, liquid, solid ("DRY-ICE") • **OHIO** — medical gases and hospital equipment • **NATIONAL CARBIDE** — pipeline acetylene and calcium carbide • **COLTON** — polyvinyl acetate, alcohols, and other synthetic resins.

Circle 453 on page 19



CLARE RELAYS and AUTOMATION

Cutaway view of CLARE Mercury-Wetted-Contact Relay, two of which are used by AccuRay to control cigarette making process.

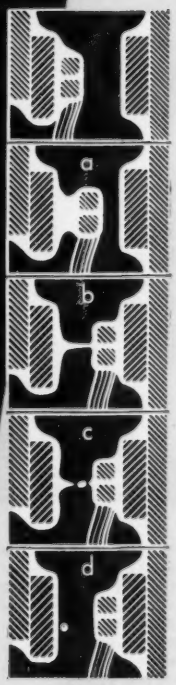
How *AccuRay* uses long-life CLARE Mercury-Wetted-Contact Relays to provide accurate, continuous and automatic control of a manufacturing process

Actuated by variations in the electric current set up by a constant intensity beam of radiation through a cigarette "rod," two CLARE Mercury-Wetted-Contact Relays help the AccuRay Cigarette-Gauge controller to proportion the weight of cigarettes as they are being produced.

In this way AccuRay, a revolutionary precision process control system, uses electronics to provide automatic control of cigarette and other manufacturing production processes.

Engineers of Industrial Nucleonics Corporation, makers of this new process control, picked CLARE Relays to perform these important functions because only these relays gave the long life and low maintenance required. These machines wrap and cut 20 cigarettes a second, day and night, day after day.

With a service life of billions of operations* it is no wonder this relay has become the first choice of hundreds of leading designers of computing, data-processing and control equipment. For complete information write for Bulletins 120 and 122 to C. P. Clare & Company, 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: 659 Bayview Avenue, Toronto 17. Cable address: CLARELAY.



Drawings (left) from high-speed photographs show the cycle. (a) Filament of mercury forms between the contacts as they separate. (b) This becomes narrower in cross section and (c) finally parts at two points, allowing globule of mercury to fall out. Mercury flows up the capillary path, replaces amount lost, restores the equilibrium. (d) The momentary bridging of the parting contacts—and the extremely fast break that ends it—minimizes the arc and adds greatly to contact load capacity. Contact closure between the two liquid surfaces bridges mechanical bounce and prevents any chatter from appearing in the electrical circuit.

** More than two years ago a life test started on a group of these relays carrying a full contact load of 5 amperes at 50 volts d-c with suitable spark suppression. They have been operating continuously ever since at 5,184,000 operations a day. They have now passed the 4 billion mark—and the end is not yet in sight.*

CLARE RELAYS

FIRST in the industrial field

Circle 454 on page 19

WARNER ELECTRIC CLUTCH COUPLINGS SOLVE HIGH-SPEED RECORDING PROBLEM

Automatic transmission for remotely controlled, recording oscillograph permits speed changes without stopping machine

Here's an example of how designing Warner electric clutch couplings and brakes into the original unit get results that couldn't be obtained any other way. That's the story of the Cathode Ray Oscillograph Recorder for high-frequency phenomena designed and built by William Miller Instrument Company, Pasadena, California.

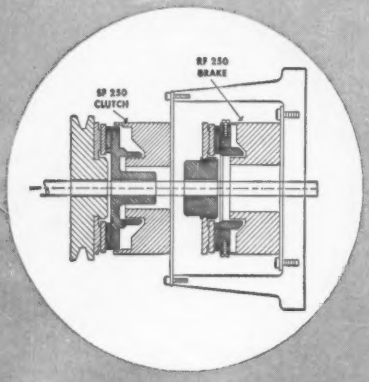
A total of 10 Warner electric clutch couplings and one RF-250 brake are used in the transmission to control recording speeds and in the magazine to control flow of photosensitive recording paper. The Warner clutch couplings in the transmission permit remote pushbutton selection of recording speed ranging between 3 and 400 inches per minute without stopping machine.

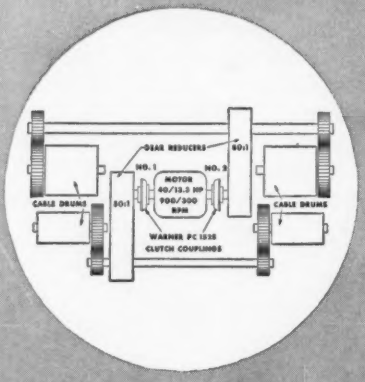
In addition, removing the magazine for darkroom processing of recording paper is also simplified because Warner Clutch-Couplings were incorporated into the original design. All that is necessary is to de-energize the field, unlock the magazine case, and slide the armatures away from their respective fields and rotors.

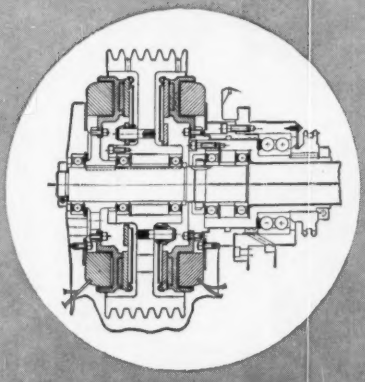
Pushbutton, centralized control that can be custom-designed right into the machine's electrical requirements is yours with Warner Electric Motion Control. Split-second operation and precise control for automatic cycling, indexing, positioning, starting, and stopping guarantee that your machines have the design advances your customers want. Capacities range from 8 in. lb to 700 ft. lb, maximum static torque rating.

Instantaneous shift in recording rate, when required, is pushbutton controlled (above). Removing magazine for darkroom processing of recording paper requires only the de-energizing of two Warner electric clutch couplings, showa at right, and unlocking the magazine.

SOLVE POWER PROBLEMS LIKE THESE QUICKLY, EASILY



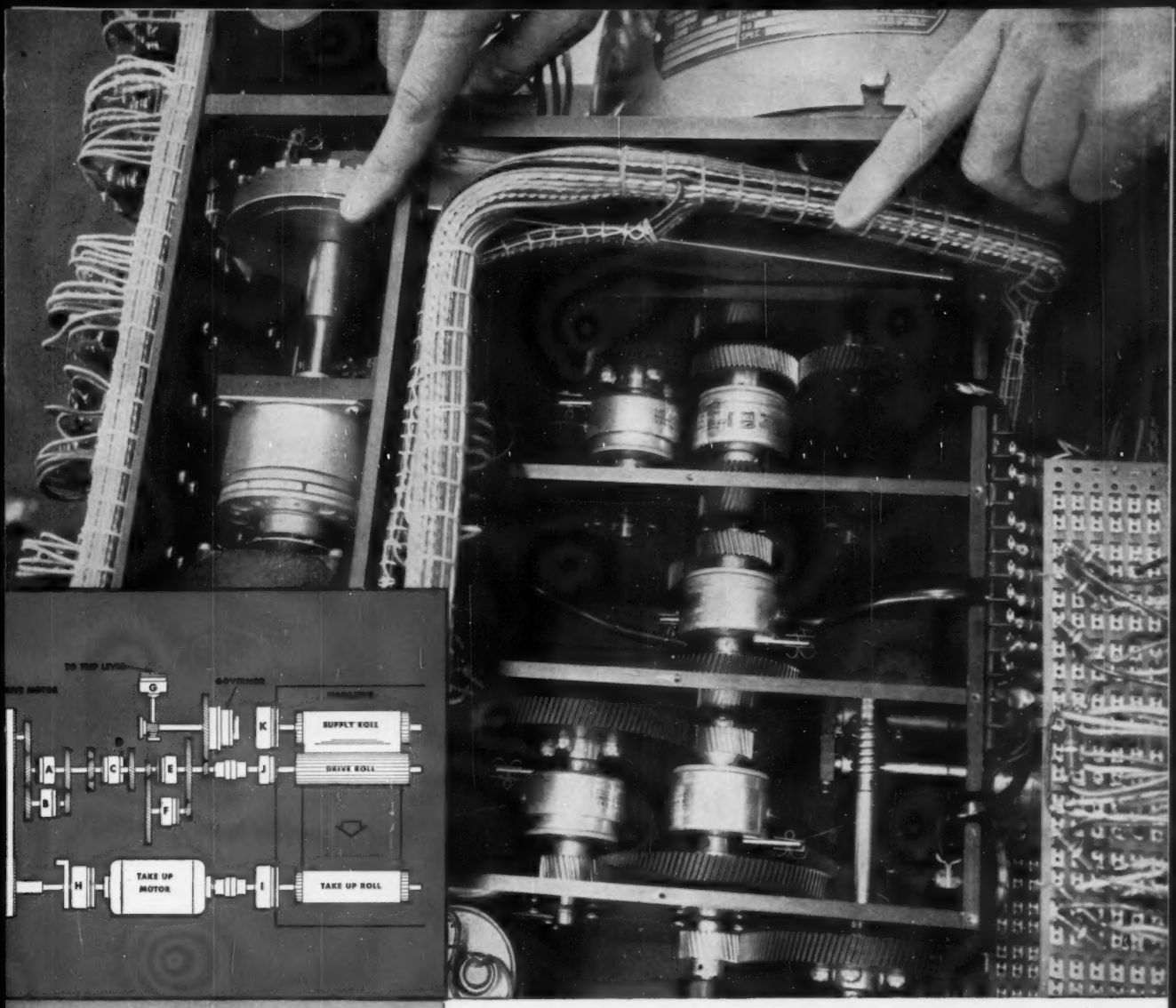


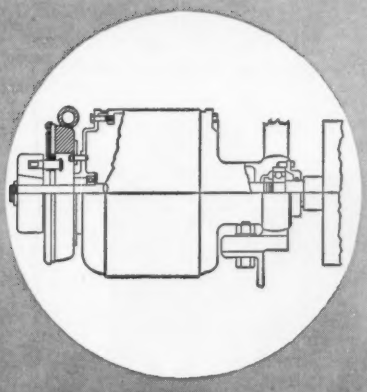


Brake and Clutch on Electronic Computer—electric brake and clutch mounted on the same shaft in sensing and punching unit enable it to handle 100 cards per minute, requiring 6,000 starts and stops per hour. Sensing fingers read data from the punched cards, information goes to computer for solution, and answer is punched onto the card.

Clutch Couplings on Gantry Crane—independent or simultaneous operation of two double drum hoists enables loads up to 25 tons to be handled at either 8 or 24 hook feet per minute, depending on whether 300 or 900 rpm motor winding is energized. Clutch couplings are actuated by pushbutton from the operator's cab, with each handling two drums.

Clutches on Turret Lathe—two electric clutches, plus one constant-running-drive motor belted to a constant-speed drive sheave are all that is needed to stop, start, reverse, or jog turret lathe spindle. Forward clutch is keyed to drive shaft and through gearing to machine spindle. Reverse clutch, keyed to sleeve around drive shaft, drives spindle through chain and gearing.





Ten Warner electric clutch couplings and one electric brake are used in the Miller Oscillograph as shown and in photo diagram above. Six SF-160 clutch couplings (A to F) are used in pairs in each of three sections in the transmission gear train. Section 1, using clutches A and B, provides a 2:1 speed reduction; section 2, using clutches C and D, provides a 4:1 reduction; and section 3, using clutches E and F, provides a 16:1 reduction. Clutch G, coupled to the main drive through a gear set, controls the length of paper to be run for recording. Clutch H couples the main drive to rewind shaft when a high recording rate requires faster acceleration of take-up roll rotation than is possible with small rewind motor alone. Two clutch couplings (I and J) are used to couple main drive shaft and take-up shaft to their respective rolls. Brake K stops the supply roll and keeps it from unwinding when machine power is cut off by the governor.

WARNER

Beat Competition with

ELECTRIC BRAKES AND CLUTCHES

Brake on Textile Machine—brake magnet is stationary-mounted to motor housing. Armature is mounted on drive pins to hub, which is keyed to a shaft driving the brush roll. Perfectly synchronized stopping of eight rolls is accomplished by adjustment of individual rheostats in the control panel. Tearing and piling of material between rolls have been eliminated while stopping the machine.

Circle 455 on page 19

Warner Electric Brake & Clutch Co.
Dept. MD, Beloit, Wisconsin

Please send me copy of your new Condensed Catalog No. 6212

Name_____ Title_____

Company_____

Address_____

City_____ State_____

Maybe you're paying for top quality "Commercial Grade" Roller Bearings...BUT ARE YOU GETTING THEM?

Cutaway view of Rollway Tru-Rol® segmented-retainer roller bearing ... one of three distinct types of Tru-Rol bearings available.

True, there's a wide difference in quality and cost between the low-range and high-range of any "commercial grade" bearing. But every Rollway Tru-Rol "commercial grade" bearing approximates as closely as possible maximum standards of construction consistent with the price.

Take the matter of separators, for example: In Rollway bearings, separators give maximum guidance to each roller. The result is greater total load capacity and longer life.

Equal spacing of rollers means uniform distribution of load. The result is the elimination of destructive "pulse" and vibration.

Moreover, separators are of deep section, formed to the curve of the rollers, giving true axial alignment, smooth-surface contact and an even lubrication film on each roller.

It's little things like these that mount up to big savings in service. Check the accompanying list, or ask a nearby Rollway Service Engineer to explain in detail the quality you should be getting in your "commercial grade" bearings. No cost. No obligation. Just write us. Rollway Bearing Co., Inc., 586 Seymour St., Syracuse, N. Y., *manufacturers of a complete line of radial and thrust cylindrical roller bearings.*

ENGINEERING OFFICES: SYRACUSE • BOSTON • CHICAGO • DETROIT • TORONTO • PITTSBURGH • CLEVELAND • MILWAUKEE • SEATTLE • HOUSTON • PHILADELPHIA • LOS ANGELES • SAN FRANCISCO

Check This List AND BE SURE!

Retainer Operation

☐ Is the retainer roller-supported, to reduce sliding friction?

Retainer Construction

☐ Is the retainer strong enough to withstand shock loads and sudden reversals?

(A Rollway segmented-type steel retainer, such as that illustrated, is the strongest, most durable available in commercial grade bearings.)

Roller Spacing

☐ Are all rollers equally separated, or do some rub against each other in opposed-motion friction?

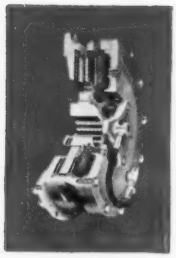
☐ Are rollers distributed evenly to prevent "pulse" and vibration?

Roller Construction

☐ Are the rollers crowned for optimum load distribution?

For Top Quality in Every Detail Buy Tru-Rol and Be Sure!

Circle 456 on page 19



BIRDSBORO found

STEEL FDRY. AND MACHINE CO.

WICHITA

CLUTCHES and BRAKES

☆ *Practical to apply* ☆ *Reasonable in price*

☆ *Supported by good engineering and service*

OTHER OUTSTANDING FEATURES

- SAFER OPERATION
- COOLER RUNNING
- NO ADJUSTMENTS
- NO LUBRICATION
- EXTREMELY LONG LIFE
- FASTER ENGAGEMENT AND DISENGAGEMENT
- VERY LOW MOMENT OF INERTIA
- EASIER MAINTENANCE

Pictured is a 500 ton Birdsboro Up-and-Down Shear for cutting blooms and beam blanks hot. The Wichita Clutch is mounted directly on the flywheel. The Wichita Brake is on the opposite end of the shaft.

Birdsboro Engineering Dept. states, "We were losing sales on shears until we installed WICHITA CLUTCHES. For some time we had been trying to apply air-operated friction type clutches to our shears, but only WICHITA Clutch Engineers were able to give us a clutch that was satisfactory."

"Wichita Clutches have benefited our equipment most because they eliminate the need for either unsatisfactory mechanical jaw-type clutches or expensive direct drive start and stop."

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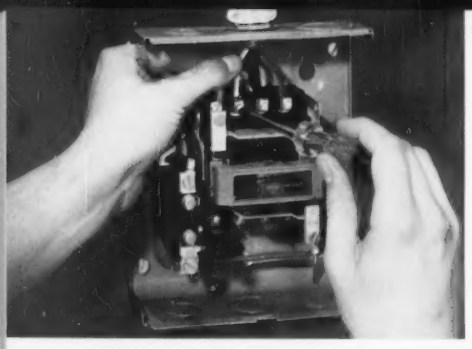
R. E. Kunz, Seattle, Wash.
W. G. Ballantyne & Co., Portland, Ore.
Norman Williams, Houston, Texas

WICHITA Clutch COMPANY, INC.
WICHITA FALLS, TEXAS, U. S. A.

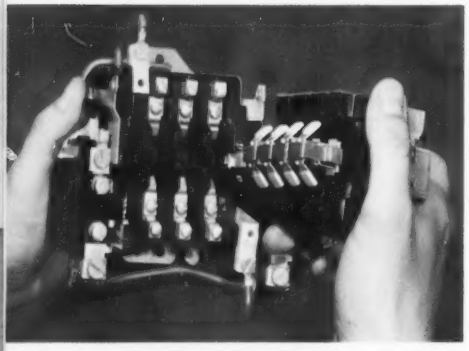
Circle 457 on page 19

Circle 458 on page 19→

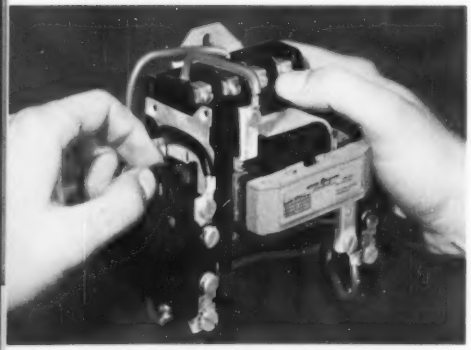


NEW **GREATER WIRING SPACE**
Wrap-around cover—removable enclosure sides make wiring much easier.

NEW **SNAP-SLIDE CONSTRUCTION**
Principal components quickly disassembled for easier inspection and maintenance



NEW **"VERTICAL" CONTACTS**
Continuous dependable operation of new starter—even in dusty atmospheres



NEW **ADJUSTABLE OVERLOADS**
Overload trip setting can be adjusted plus or minus 15% of nominal heater rating.

General Electric announces

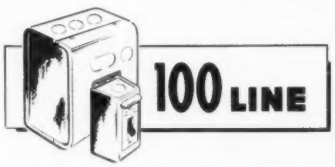
NEW Size 0 and 1 Magnetic Starters—42% Smaller in Size

General Electric now offers a new line of Size 0 and 1 magnetic starters that is 42% smaller than previous open forms and is built to the new NEMA ratings. The new starters with "snap-slide" construction provide easier inspection and maintenance because principal components snap or slide together. Completely new and radically different in design, this line of starters offers:

- wrap-around cover with spring latch—easily removed without tools for inspection
- removable sides for greater accessibility
- straight-through wiring speeds installation
- pressure-type terminals make wiring easy
- vertically-slanted contacts give higher tip pressure, reduce possibility of contact welding
- long life "kick-off" spring provides clean break of contacts in any mounting position
- strongbox coil with Mylar* insulated start wire for longer coil life
- overload relays adjustable for ±15% of trip setting
- nine field modification kits for greater flexibility
- new maximum NEMA ratings up to 7½ hp at 220 volts and 10 hp at 440 volts

Two additional features of the new magnetic starter are extremely quiet operation and lower inrush requirements of the coil. Sound absorbing material around the magnet lowers the operating noise level. Lower coil inrush current will allow you to use a 47% lower rated control transformer with this starter—saving you money and mounting space.

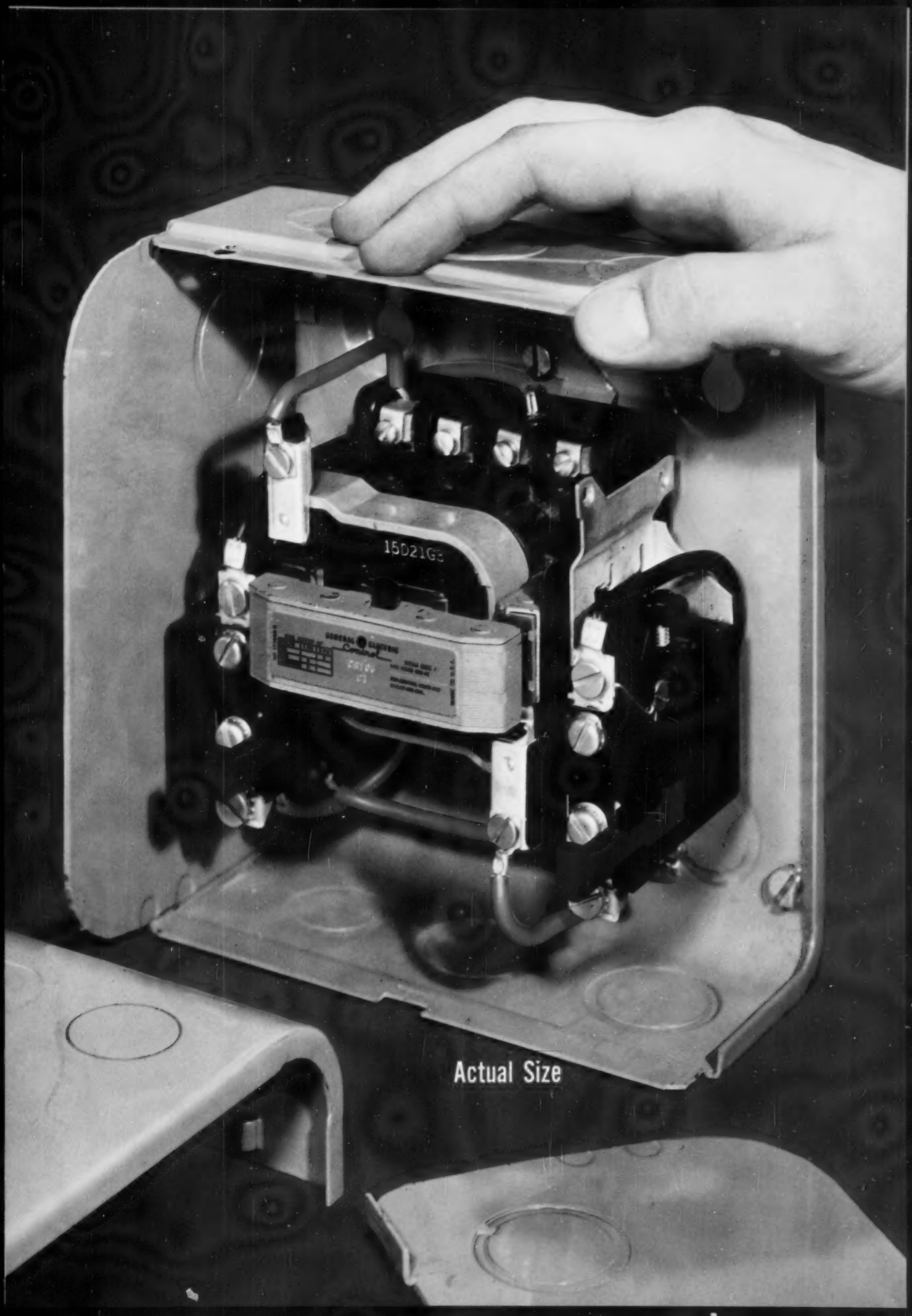
Size 0 and 1 General Electric starters are available now in non-reversing, combination, reversing and multispeed forms. Contact your nearest General Electric Sales Office or Distributor, or write Advertising Section 731-13 for the 20-page bulletin describing the line. Ask for GEA-6611. General Electric Company, Bloomington, Illinois.



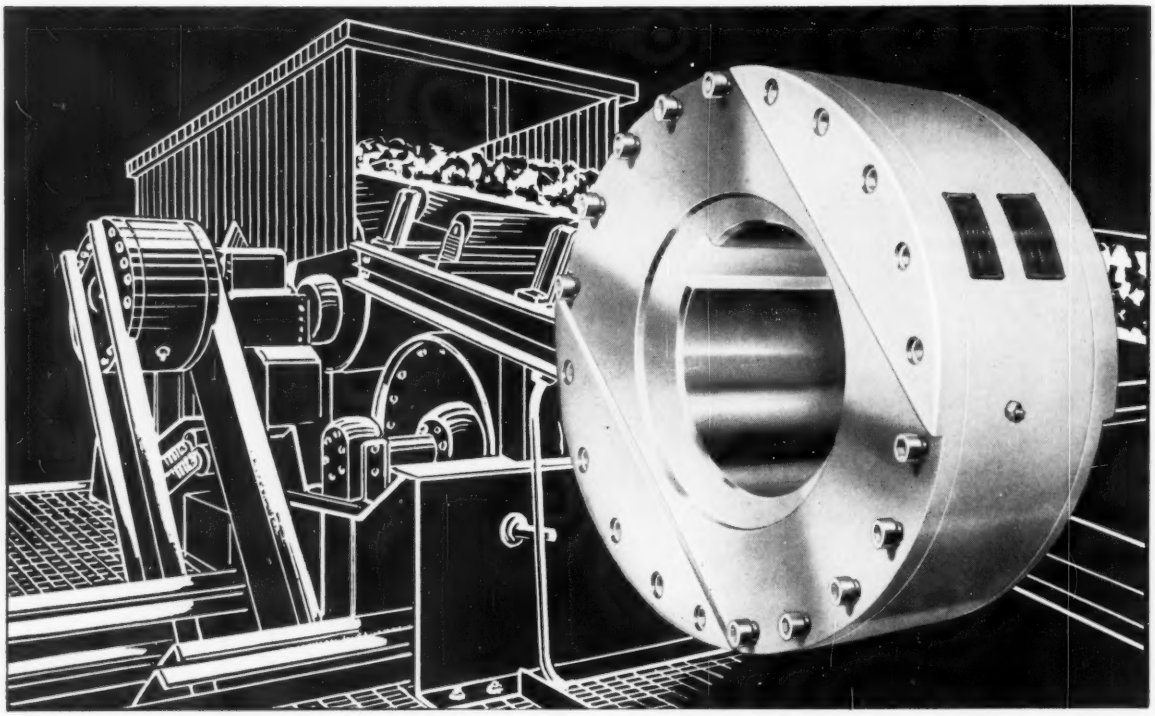
*Trade-mark of DuPont Co.

Progress Is Our Most Important Product

GENERAL ELECTRIC


15D21GE
Actual Size

136,500 Ft.-Lbs. of Holdback Torque



New Heavy-Duty Design

FORMSPRAG "Positive Action" BACKSTOPS

Here, at last: Positive protection from hazardous reverse torque-runaway. Thorough-going tests on all major makes of inclined conveyor and elevator equipment have proven Formsprag Large Bore Backstops guard both your personnel and your machinery against dangerous and damaging "runback".

No more runback worry from conveyors stalled because of overload or power failure. You're now fully protected. What's more, you stop reverse torque at its source, the headshaft. So, maintenance headaches caused by many present inadequate reverse torque controls are minimized.

All Formsprag Large Bore Backstops employ the modern sprag-type clutch principle—proven so successful on a wide range of over-running and indexing applications. This guarantees you these important advantages:

Greatest torque capacity to weight ratio. Ball-bearing construction for longer life and smooth over-running. Mechanical seals to prevent entry of abrasives. Individually energized spring-loaded sprags. Grease lube is required only twice yearly.

Next time you have a power transmission application on an inclined conveyor or elevator, protect yourself, specify Formsprag.

FOR MORE INFORMATION . . .

Write today! This new 26 page catalog will be sent immediately.

CHECK THESE CAPACITIES

MODEL NO.	MAXIMUM OVER-RUNNING SPEED RPM	TORQUE CAPACITY LB. FT.	APPROXIMATE WEIGHT LBS.
FS-1100	185	18500	350
FS-1150	170	24000	450
FS-1200	140	36000	650
FS-1250	130	51500	1000
FS-1300	115	73000	1250
FS-1400	100	136500	2200

Over-Running, Indexing and Backstopping Clutches for aircraft, automotive and various industrial applications

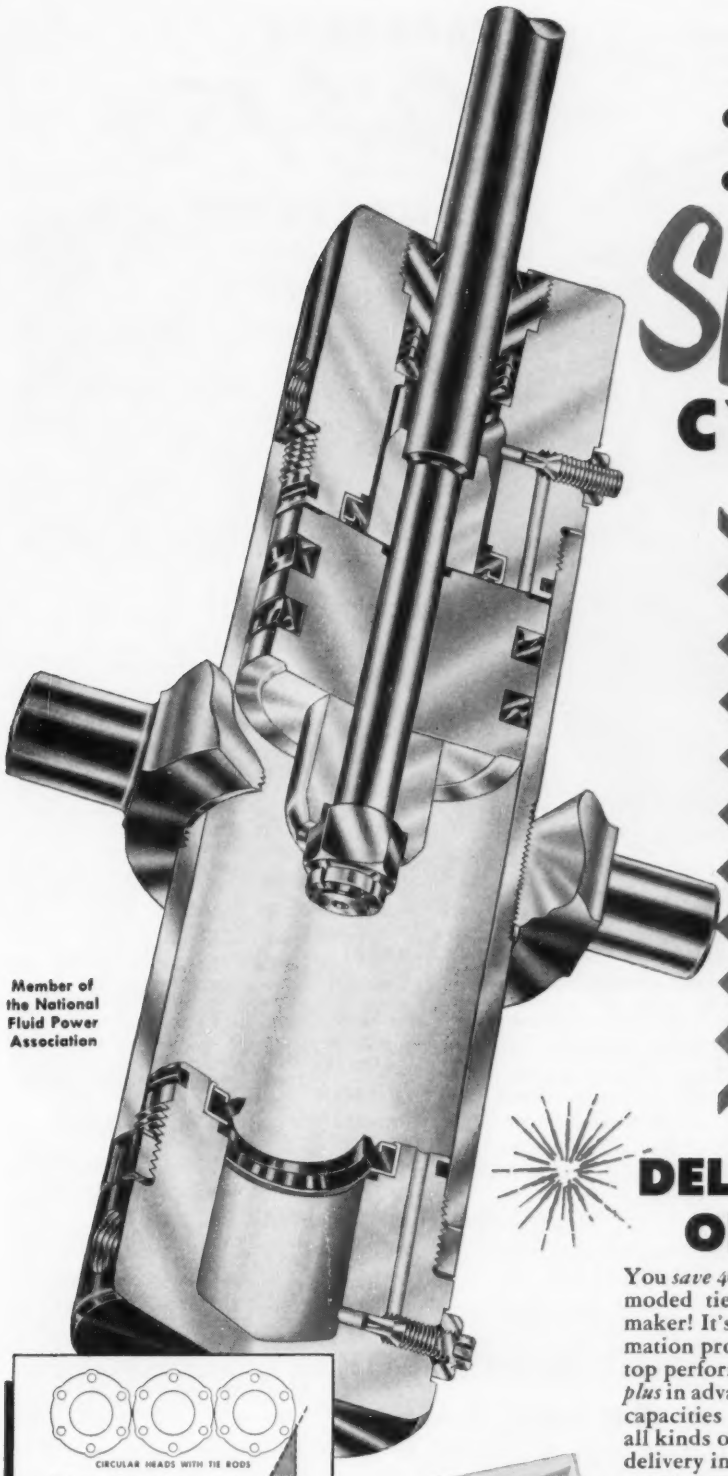
FORMSPRAG COMPANY

23603 HOOVER ROAD • WARREN (DETROIT), MICHIGAN

World's largest exclusive manufacturer of over-running clutches

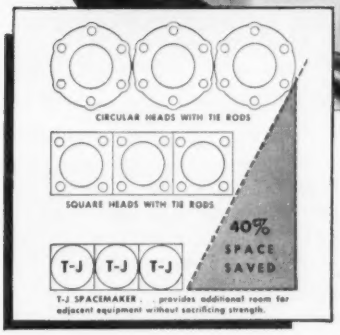
Distributors in principal cities

all the EXTRAS are standard with T-J Spacemaker CYLINDERS



Member of the National Fluid Power Association

- **NEW** *exclusive* ingenious cushion designs . . . Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Cushion for Oil.
- **STRONGER** than outmoded tie rod design, proven through actual tests. No tie rods to stretch.
- **SOLID STEEL HEADS** throughout the full line.
- **COMPACT DESIGN** eliminates tie rods, increasing the strength and reducing mounting space required, providing extra room for adjacent equipment.
- **HARD CHROME PLATED** body bores and piston rods . . . assure you of long trouble-free service. (Standard at no extra cost.)
- **METALLIC ROD SCRAPER,** not just a wiper, actually removes foreign matter from the rod.
- **PILOTED PACKING GLAND** with extra long bearing. Additional strength and support to the piston rod.
- **OIL** pressure to 750 p.s.i. AIR to 200 p.s.i.



DELIVERY OFF THE SHELF!

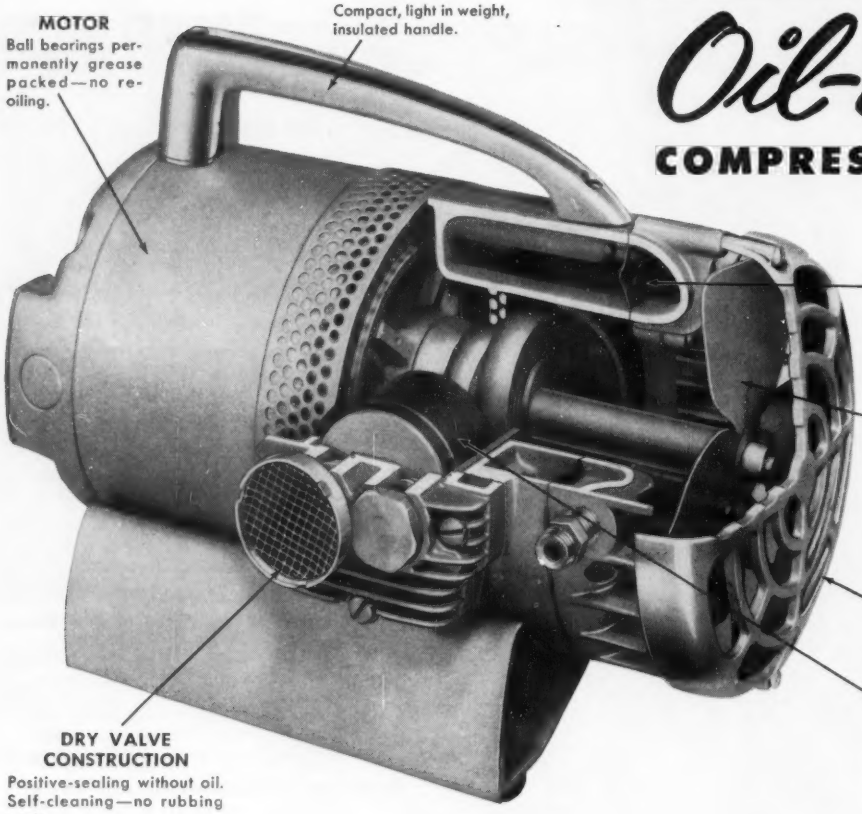
You *save 40% space* when you switch from outmoded tie rod cylinders to the T-J Spacemaker! It's stronger, too! Fits right into automation programs in countless plants. Delivers top performance and dependability with a big *plus* in advanced features. Wide range of styles, capacities . . . reduces man-hours and costs in all kinds of push-pull-lift operations. Off-shelf delivery in 64,000 combinations!

NEW LITERATURE—Send today for new Catalog SM56 with complete engineering details on Spacemaker line. Write The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVITORS . . . AIR AND HYDRAULIC CYLINDERS . . . CUTTERS . . . CLINCHERS

Circle 460 on page 19

PACKAGED *Oil-Free* COMPRESSED AIR



AIR WHERE YOU WANT IT... COMPLETELY OIL-FREE... COOLER... DRIER!

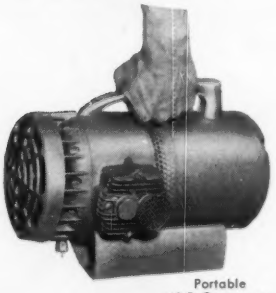
Expensive lubrication maintenance completely eliminated!

Where *clean* compressed air is essential, the B&G Oil-less Compressor provides the answer in a complete line of portable, tank-mounted and tankless models.

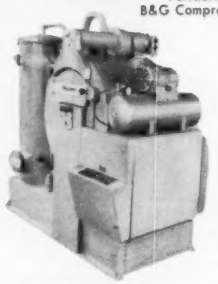
There is no oil required in this new design unit! Motor and compressor are permanently grease packed... graphite piston rings and skirts operate for years without destroying the mirror-finish of the cylinder walls. Since the cylinders are not lubricated, oil-free air is delivered at all times without need for an oil separator.

B&G Compressors are really *smooth!* Modern design large bore, short stroke, horizontally opposed pistons provide better balance and vibrationless operation. Compactness and light weight adapt them ideally to either portable or built-in applications. In every detail these units are designed to deliver *maximum air per horse power!*

For complete information on B&G Oil-less Compressors and Vacuum Pumps, send for Catalog GO-1156.



Portable B&G Compressor



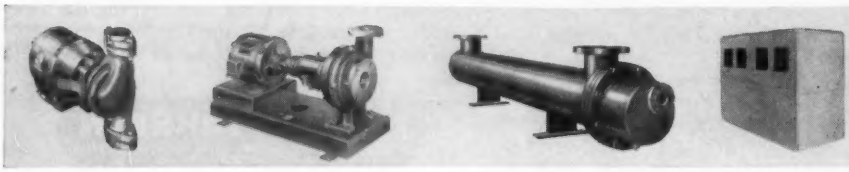
B&G Oil-less Air Compressor as integral part of dry cleaning machine

Oil-less AIR COMPRESSORS

BELL & GOSSETT

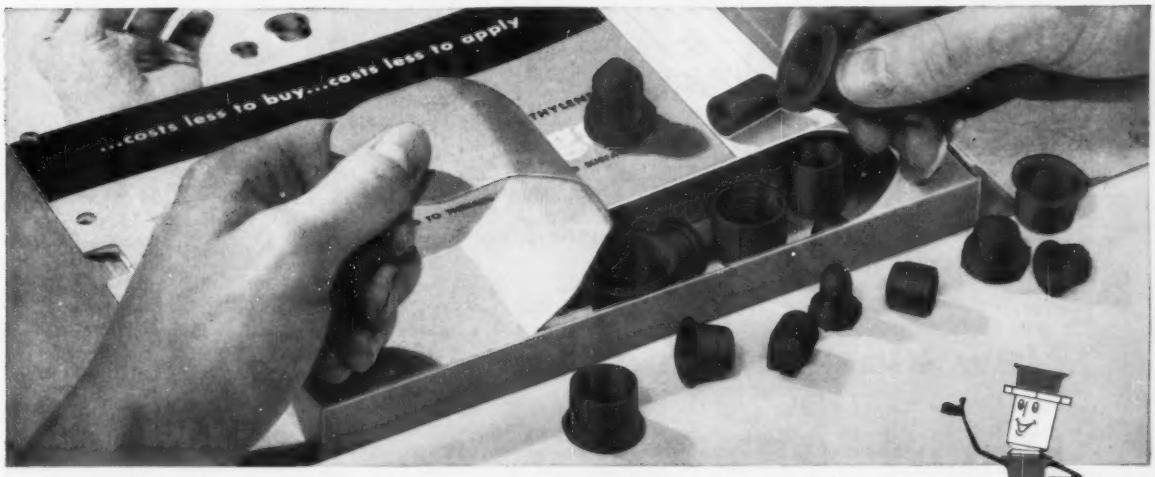
COMPANY

Dept. EZ-67, Morton Grove, Illinois



MAKERS OF HEATING AND COOLING SPECIALTIES, PUMPS, HEAT EXCHANGERS

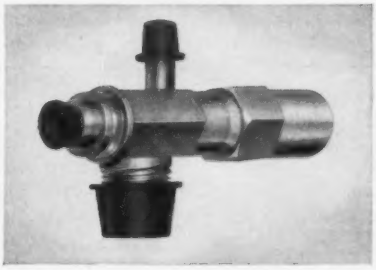
which **CaPlug** will protect <u>your</u> product best?



write for this free sample kit and see!

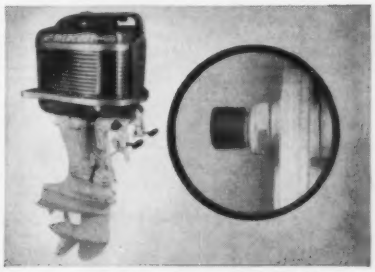
WANT TO SEAL OPENINGS IN A JIFFY?

Tapered (non-threaded) CaPlugs can be used as caps or plugs, inside and outside of threaded or plain fixtures. Just push them on . . . or push them in. Costing less to buy, these versatile closures cost less to apply. Time studies show that tapered CaPlugs save up to 500% in labor costs.



WANT TO KEEP FITTINGS UNDER WRAPS?

See how CaPlugs seal out dust and protect fittings of this refrigeration valve during shipment. Says Automatic Machine Products Sales Co., "It is important that the valve be free from contamination, since a large percentage of refrigeration systems are hermetically sealed and guaranteed for five years. CaPlugs are easy to install and afford the protection we desire."



WANT TO PROTECT DELICATE THREADS?

Kiekhaefer Corp. guards the threads on the "Ride Guide" steering controls of its Mercury outboard motor with *threaded style* CaPlugs. Here's long-lasting protection . . . the customer can reuse the CaPlugs when storing his motor. Made of tough, flexible Polyethylene, CaPlugs are especially kind to threads and polished surfaces — will not collapse, chip, break or shred.

WANT TO ADD SALES APPEAL?

Colorful CaPlugs spruce up your product and reflect the care you have taken to keep delicate systems free of dirt, moisture or foreign matter. This Bristol air control instrument is a good example. Says The Bristol Company, "They are sturdy enough so that they are not accidentally dislodged, but are still easily removable."

CAPLUGS FIT PRACTICALLY ANY CLOSURE NEED YOU CAN NAME.

Ten standardized designs (both threaded and non-threaded) are stocked in over 500 sizes to give you low-cost protection for tubing, fittings, valves, hydraulic components and machined parts of every description. Your immediate requirements can be met promptly with "off-the-shelf" deliveries from a multi-million inventory.

MAIL THIS COUPON FOR FREE CAPLUG SAMPLE KIT WITH DESCRIPTIVE LITERATURE AND PRICES

CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC., 2201 Elmwood Ave., Buffalo 23, N.Y.

RUSH a free CaPlug sample kit, literature and prices to us, without obligation.

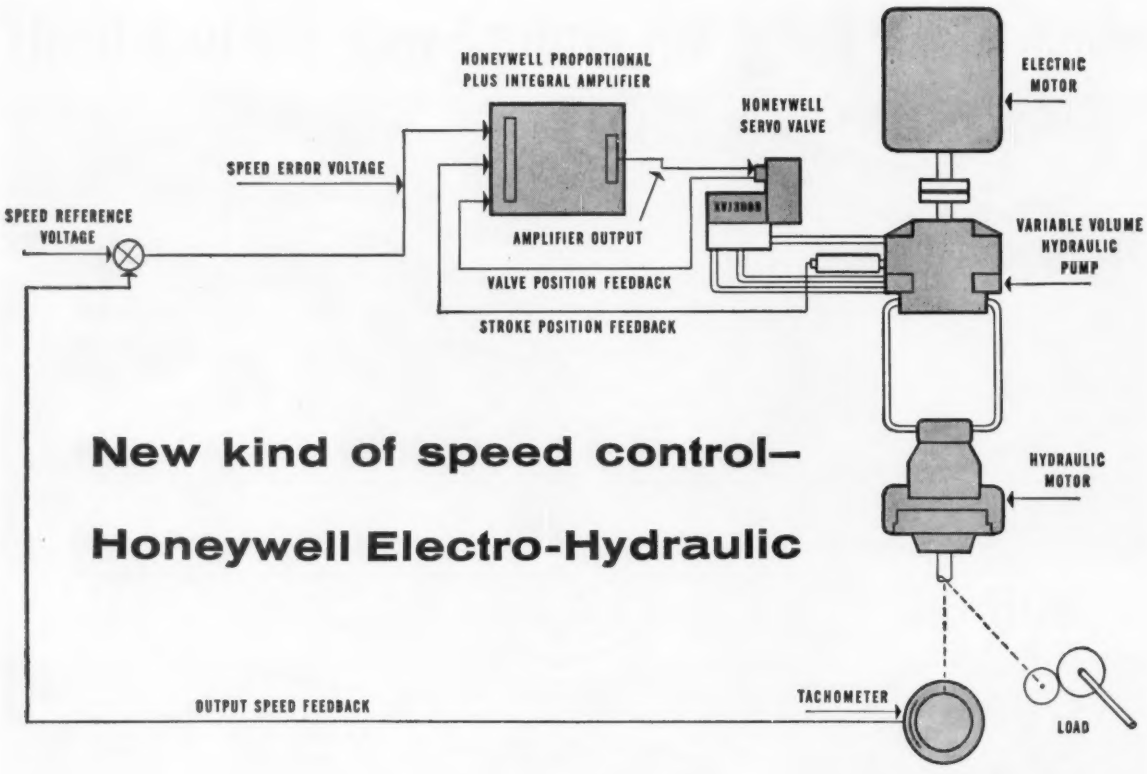
NAME _____ TITLE _____

FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

Circle 462 on page 19



Only an electro-hydraulic speed control system can give you all these advantages.

- Wide speed range—ranges of 1,000 to one are readily possible
- Smooth, steady, low-speed operation
- Fast response
- Negligible droop under load
- Infinitely variable speed control
- Easily adjustable speed

THE SPEED CONTROL diagram above is a typical example that shows the flexibility of Honeywell Electro-Hydraulic Control systems.

Honeywell servo valves and transistor amplifier combinations make new building blocks available for dozens of applications.

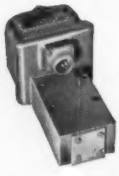
Rugged and dependable, they are smaller and more compact, have high speed of response, are easy to adjust and inexpensive to install.

For complete information, including realistic delivery dates, call, wire or write Minneapolis-Honeywell Machine Controls Division, Dept. MD10-210, Minneapolis 8, Minn.

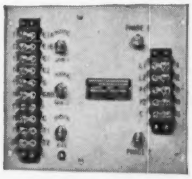
Flexible building blocks to do the job

3-Way Valve (XVJ300)
Output Flow (no load)
100 psi—3.5 gpm
1000 psi—9.9 gpm

4-Way Valve (XVJ303)
Output Flow (no load)
100 psi—1.5 gpm
1000 psi—5.0 gpm



3-Way Valve (XVJ302)
Output Flow (no load)
100 psi—2.0 gpm
1000 psi—6.0 gpm



Amplifier (XRJ301)
Transistor Servo Amplifier
High gain, multiple input amplifier with superior reliability.

Honeywell

First in Controls

Circle 463 on page 19

Self-aligning

FOR LONGER LIFE

Not even misaligned shafts or supports impair the efficiency of this easy-to-mount LINK-BELT roller bearing

THE equipment manufacturer seeking lower manufacturing costs plus the ultimate in free-rolling efficiency need look no further than this Link-Belt roller bearing.

- **SELF-ALIGNMENT** compensates for inaccuracies in machining and assembly of equipment.
- **EASY MOUNTING.** Bearing is securely and quickly locked by a heavy collar to commercial shafting.
- **COMPACTNESS** offers design flexibility.

You'll find equally important economies throughout industry's most complete line of ball and roller bearing blocks. Ask any one of 40 Link-Belt offices for Book 2550 containing full information.

Series 400 roller bearings

FREE ROLLING—SELF ALIGNING. Spherical inner ring aligns freely in any direction. Load is distributed over entire roller, assuring full capacity. Destructive edge loading cannot occur.

LINK-BELT

self-aligning ball and roller bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14 440-A

Westinghouse AV-DRIVE gives constant surface speed regardless of work diameter

. . . at R. H. Bouligny, Inc., Charlotte, North Carolina

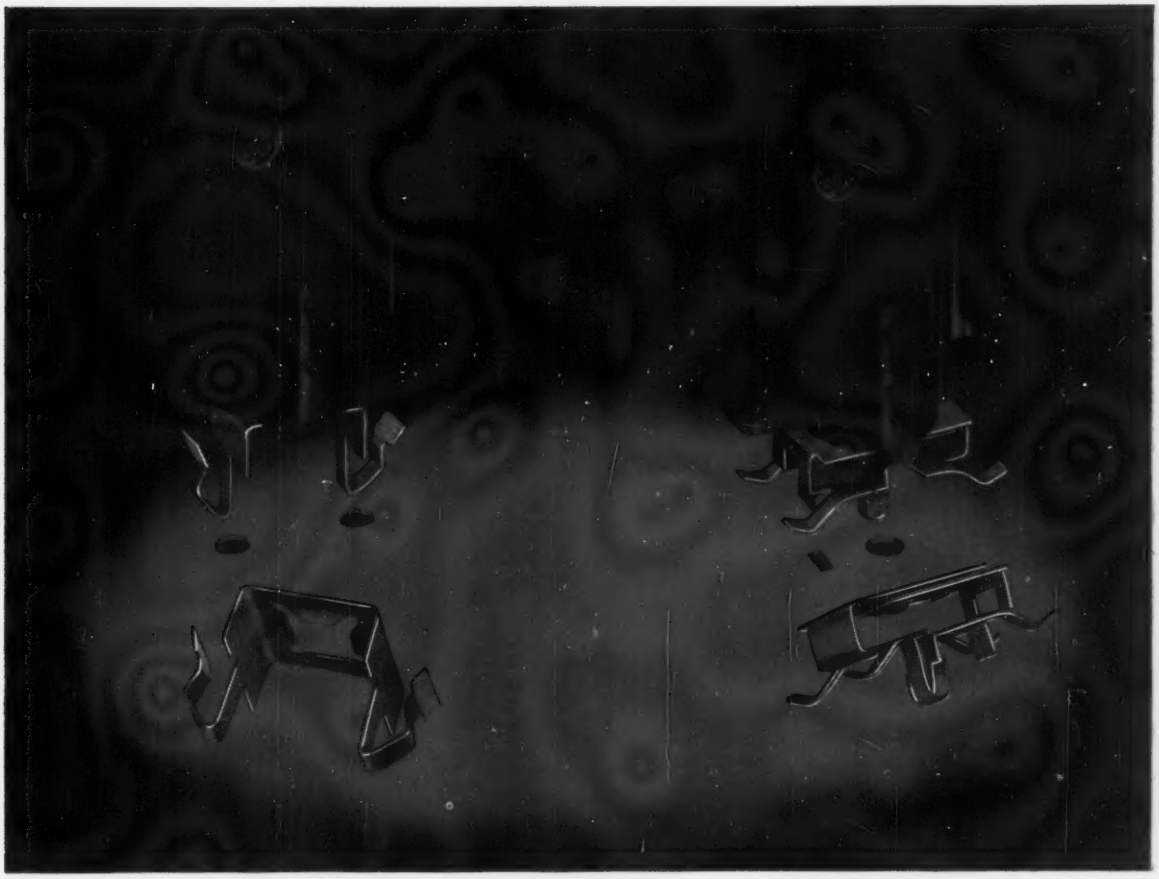
Eighteen hours a day, this tracer lathe is doing the work of an engine lathe . . . plus tracing at R. H. Bouligny, Inc., Charlotte, North Carolina. Constant surface speed, regardless of work diameter, is provided for precision template-guided cutting by a Westinghouse AV-Drive.

As the tracer mechanism traces over the template, the spindle speed is automatically controlled in accordance with tool position to maintain constant surface cutting speed. The template and work piece can be placed in the 20″ swing lathe and the machine takes over.

To learn how the versatile Westinghouse AV-Drive can make your production more profitable, call your local Westinghouse representative. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania. J-22052

YOU CAN BE SURE...IF IT'S Westinghouse

Circle 465 on page 19



Engineered by Tinnerman..

On the assembly line...and in the field plug-in **SPEED CLIPS**® simplify rectifier installation

At General Electric, two variations on a single SPEED NUT® principle are being used to make things easier for production-line assemblers and for electronics servicemen.

The basic idea of the Tinnerman front-mounting SPEED CLIP is incorporated into the sockets of GE germanium rectifiers made by GE's Semiconductor Products Department, Syracuse, for industrial electronics applications.

On the TV production line, the Tinnerman SPEED CLIP permits rapid, tight, and simple installation of rectifiers. In the field, merely by unplugging the original equipment rectifier and plugging in its germanium replacement, the serviceman can quickly get a unit back in service.

Working together, General Electric and Tinnerman engineers developed the two types of SPEED NUT parts that are fabricated right into the rectifier shells.

Unusual applications of the SPEED NUT principles to scores of different products are developed every day at Tinnerman. That's why over 9,000 different forms of SPEED NUT Brand Fasteners have been designed for all leading manufacturers.

Your fastener problem can probably be solved quickly by a call to your Tinnerman sales representative. If his name isn't in your telephone directory, write to:

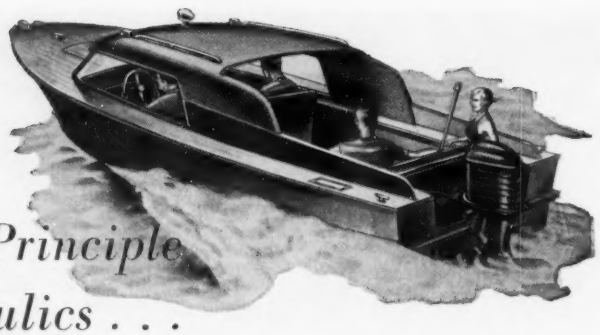
TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

TINNERMAN

Speed Nuts®

FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessaries Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Macano-Bundy GmbH, Heidelberg.



The "Outboard Motor" Principle Applied to Hydraulics . . .

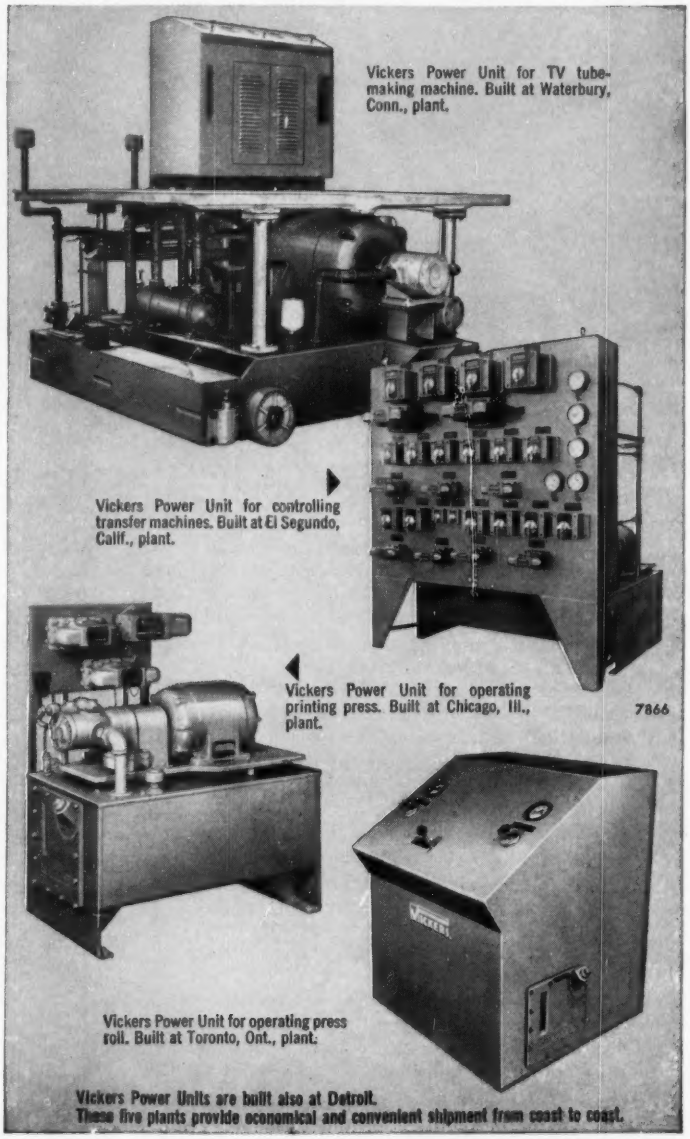
VICKERS® "Packaged" Hydraulic Power Units Are Compact, Convenient and Economical

The outboard motor is popular because it is a complete, self contained power package . . . quick and easy to apply.

Vickers Custom-Built Power Units provide a comparable packaged system for the hydraulics of any particular machine or job. Built to the exact needs, it is compact, efficient, and very quick and easy to apply.

All necessary pumps, valves, intermediate piping, motors, controls, oil reservoir, oil filters, air cleaners, oil level gauges, fittings, etc. are included, as well as electronic components if used.

You are assured dependable performance. Design is improved and simplified, time and cost of installation are reduced, appearance is better, servicing is easy. Each unit is pretested at the factory and is ready for immediate operation. Vickers undivided responsibility for the entire hydraulic control system is important to both the machine builder and his customer. Write for Bulletin 52-45.



VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1430 • Detroit 32, Michigan

Application Engineering Offices: **ATLANTA • CHICAGO CINCINNATI • CLEVELAND • DETROIT • GRAND RAPIDS HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS NEW YORK AREA (Summit, N.J.) • PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) SEATTLE • ST. LOUIS • TULSA • WORCESTER**
IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto and Montreal

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Circle 467 on page 19

FROM THESE SIMPLE, BASIC PARTS

ANY COMBINATION FITTING YOU NEED

New IDEAL SIMPLET UNIVERSAL FITTING

open-face bodies and hub-covers—easily assembled in seconds

- RUGGED, DURABLE MALLEABLE IRON
- MEET J.I.C. AND N.M.T.B.A. STANDARDS
- HUBS REVISED WITHOUT REPLACING FITTING
- LARGER WIRING AREA
- COVERS SUPPLY HUBS FOR CONDUIT — NO NEED TO DRILL
- PRECISION TAPERED PIPE THREADS
- MOUNTING LUGS, CONDUIT STOPS
- LIQUID, DUST, LINT PROOF

Ideal-Simplet introduces this revolutionary advance in conduit fitting design with the *new* Universal Fitting. It provides an almost infinite variety of hub combinations for practically any wiring job!

With only *five* basic body sizes and a wide choice of covers, every practical style and type of fitting with multiple hubs can be assembled in a matter of seconds. Your fittings inventory and overall costs can be substantially reduced. Standards, "specials" and even seldom-used styles are available immediately from stock!

It would pay you to get the facts about this new Ideal-Simplet Universal Fitting, NOW!

SEE YOUR WHOLESALER . . . or send coupon →

Pioneers in conduit fittings and electrical specialties

IDEAL

SIMPLET FITTINGS, Inc.
A Subsidiary of Ideal Industries, Inc.
1059-J Park Avenue • Sycamore, Illinois

IDEAL-SIMPLET FITTINGS, Inc.
1059-J Park Avenue, Sycamore, Ill. IDEAL

Send Universal Fitting data

Name_____

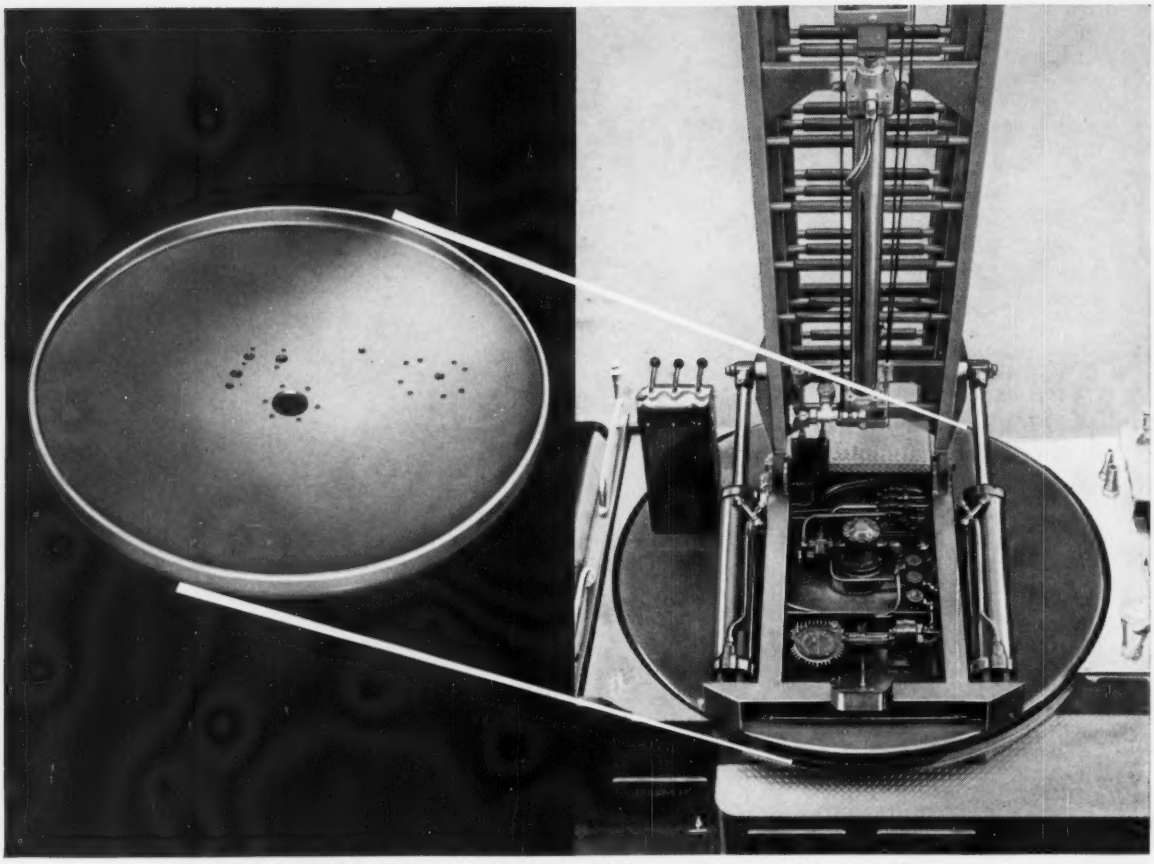
Company_____

Address_____

City_____ Zone____ State_____

Wholesaler's Name_____

Circle 468 on page 19



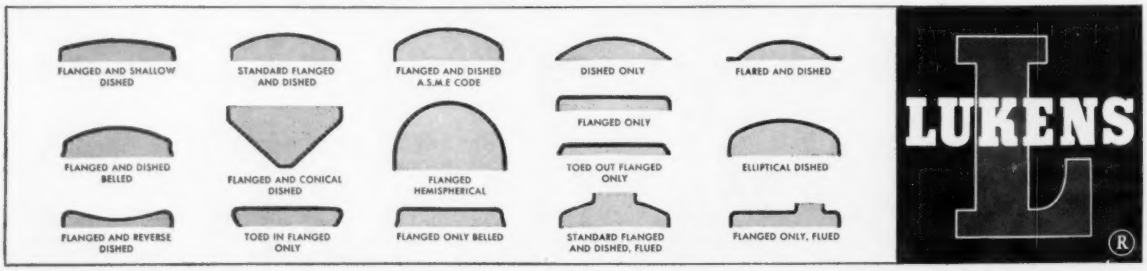
Aerial ladder builder finds notable benefits in designing turntables with Lukens steel heads.

You too can simplify, strengthen...and save... designing with Lukens heads

■ Imagination really paid off for Maxim Motor Company of Middleboro, Mass., producers of aerial ladders for fire-fighting equipment. Using a tough, one-piece Lukens standard flanged head as the ladder turntable, Maxim eliminated fabricating steps and materially lowered costs. The hydraulic mechanism was easily top-mounted for accessibility and ready maintenance.

If you build heavy or light machinery, valves, wheels —even fire engines—imaginative use of Lukens heads may improve your equipment and save you money. Lukens' fifty-five years as the leading producer of spun and pressed steel heads for many applications are at your service. Write for Catalog 937, *"Pricing and Engineering Data."* Lukens Steel Company, Coatesville, Pa.

Lukens Offers the World's Broadest Line of Spun and Pressed Heads of Carbon, Alloy and Clad Steels

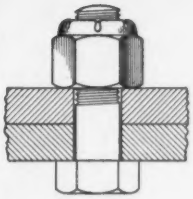


Circle 469 on page 19

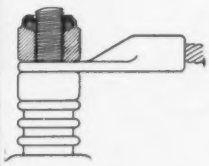
Circle 470 on page 19→

Ten fastening problems solved by ELASTIC STOP® nuts

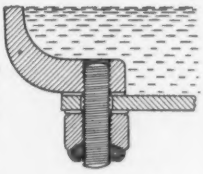
TIGHTENED AGAINST THE WORK



Vibration and impact proof bolted connections in standard applications.

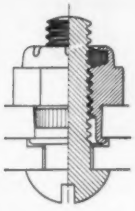


On all electrical terminals subjected to vibration in transit or operation, and for any electrical or electronic assembly where positive contact must be maintained.

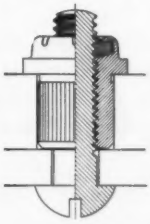


To seal bolt threads where leakage past stud threads must be prevented.

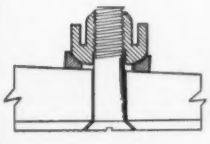
FOR MANY SPECIAL FUNCTIONS



Blind fastening applications where nut is "clinched" into sheet metal . . . becoming self-retaining as well as self-locking.

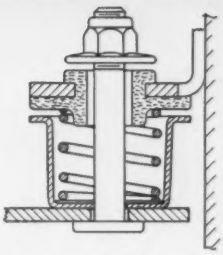


To eliminate drilling and tapping and provide steel thread strength for soft metals, an ESNA spline nut is pressed into a bored hole in casting.

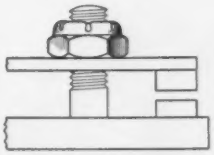


Simplified self-aligning self-locking fastener for bolting two non-parallel surfaces.

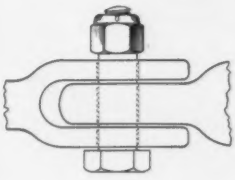
LOCKED ANYWHERE ON THE BOLT



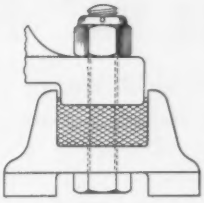
Spring-mounted connections or dynamic balancing, where nut must stay put yet be easily adjusted. (Flanged face eliminates need for extra washers.)



On make and break adjustment studs where accurate contact gaps must be maintained. Note "thin" height design for limited clearance.



For bolted connections requiring predetermined play.



For rubber-insulated and cushion mountings where the nut must not work up or down.

HOW THESE NUTS SOLVE SO MANY FASTENING PROBLEMS, ELIMINATING EXTRA PARTS AND OPERATIONS...

The red locking collar of an ELASTIC STOP® nut grips bolt threads with a perfect fit that will not loosen under severe vibration or stress reversals, and seals against liquid seepage. By bringing nut and bolt metal thread flanks into firm contact it eliminates wear producing axial play. The elastic locking action of the insert-type stop nut does not distort or gall bolt threads. It is reusable many times.

Send for the following free information: Elastic Stop nut bulletin; Rollpin® bulletin. Or enclose a drawing of your product for specific self-locking fastener recommendations. Write to Dept. N30-104.

ESNA®
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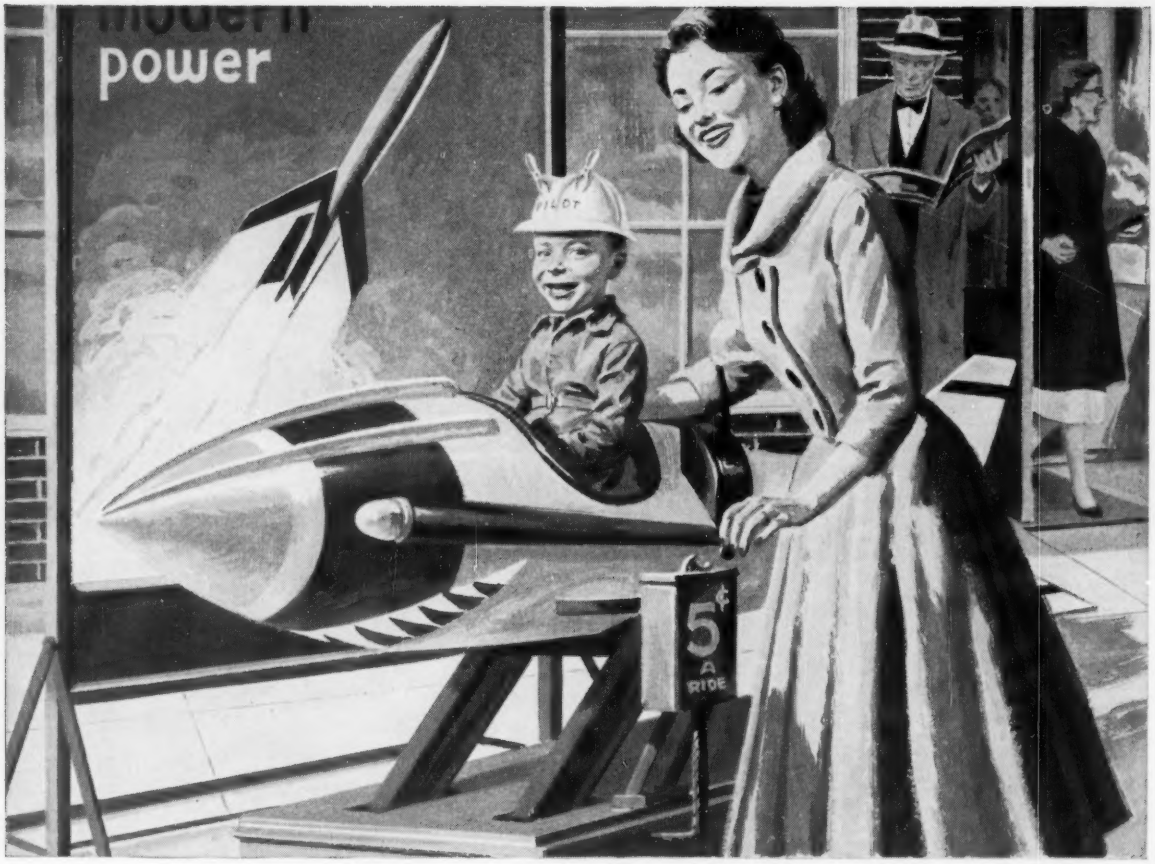
ELASTIC STOP NUT CORPORATION OF AMERICA
2330 VAUXHALL ROAD, UNION, NEW JERSEY



It Takes "A" Nickel to Make It Fly

Superior "A" nickel tubing with close tolerances and excellent properties helps today's rockets and missiles soar many miles out into the stratosphere

Superior "A" nickel tubing and many other components for these rockets and missiles are first tested extensively under the most demanding conditions engineers can devise. Tubing of "A" nickel has proved itself to have these important qualities:

- High corrosion resistance
- Strength retained at extremely high and low temperatures
- Ability to accept unusually severe fabrication
- Excellont heat transfer properties
- Unchanging properties during storage

Superior has long been one of the outstanding suppliers of aircraft quality tubing in a broad range of analyses, all produced to rigid specifications. Another example is Superior stainless hydraulic tubing, which is but one of our many tubing products being used by major aircraft manufacturers.

Make Superior *your* source of supply. We can furnish you with the finest quality small tubing obtainable anywhere. Our staff of engineers and specialists stands ready to work with you on any tubing problems of engineering or design.

For technical data on nickel and nickel alloy tubing, write us for Catalog 12. For latest information on stainless tubing, ask for Catalog Section 21. Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

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The big name in small tubing

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All analyses .010 in. to ⅜ in. OD—certain analyses in light walls up to 2½ in. OD

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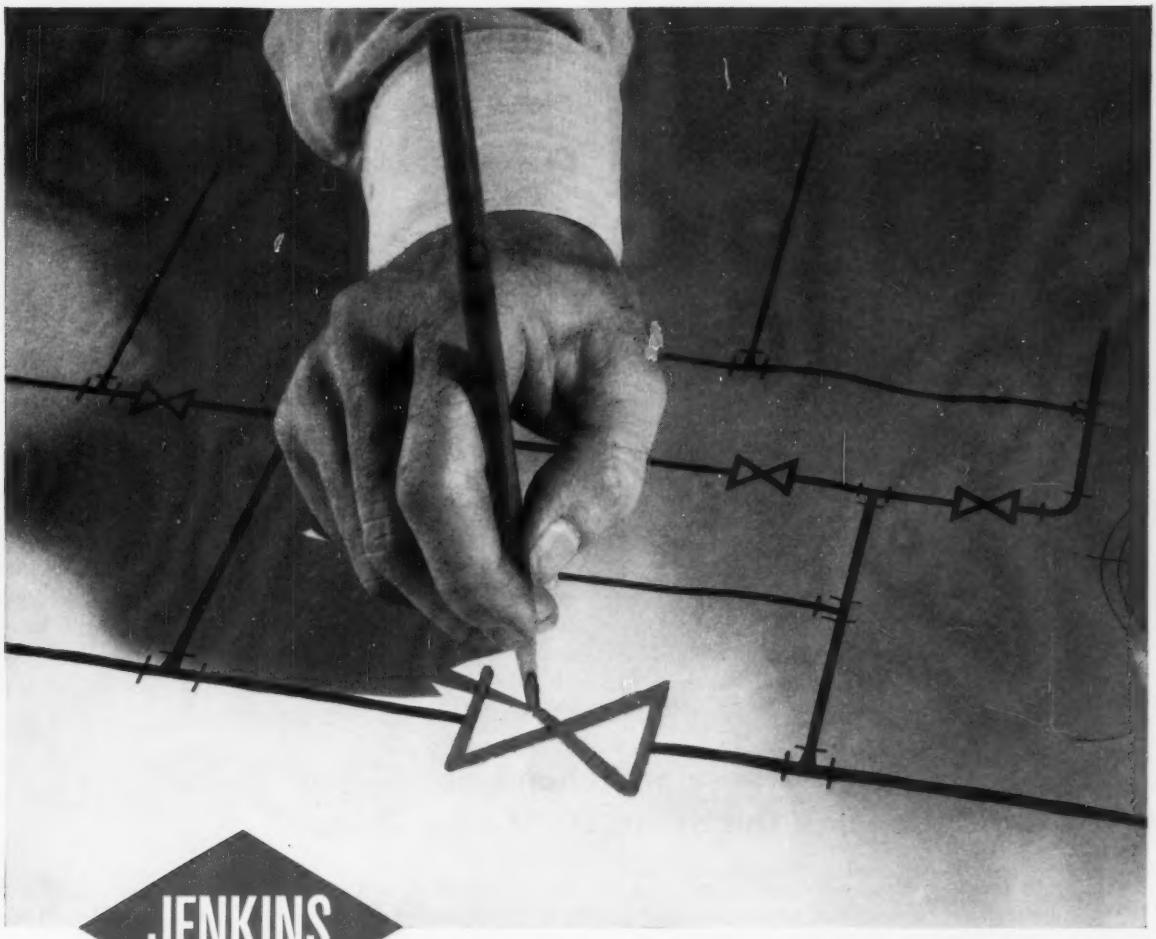

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Jenkins Bros

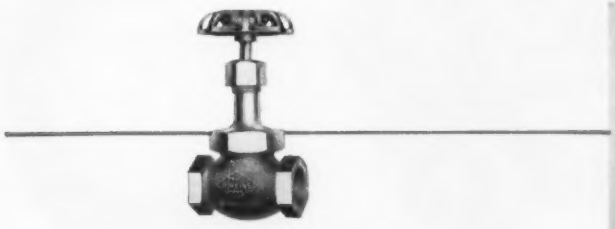
Both marks mean Valves

but only One guarantees Valve Performance

YOUR CUSTOMERS know there's a big difference in valves. A difference in performance, and in maintenance and replacement costs. A difference so important that they take great care in choosing valves for their piping systems.

WHAT valves do your customers choose? Ask them. You'll find that many standardize on *Jenkins* . . . and ALL agree there's nothing better.

Favorable reaction is certain when equipment arrives with its valves bearing the *Jenkins Diamond and Signature*. This trusted mark guarantees the finest in valve performance. It indicates quality construction throughout your equipment. Sound reasons for specifying Jenkins Valves, since they cost no more than others in the good quality class. *TELL US* the types of valves you use and we'll send information on appropriate Jenkins Valves. Jenkins Bros., 100 Park Ave., New York 17.



JENKINS

LOOK FOR THE JENKINS DIAMOND

VALVES

JENKINS® SINCE 1864 *Jenkins Bros*

Sold Through Leading Distributors Everywhere

Circle 472 on page 19

Designing with BAKELITE Plastics
BRAND

- ***Two phenolics dress up one product***
- ***Basic material for printed circuits***
- ***Simplified production for complex details***

Often your designs will call for performance properties and production techniques that only plastics can supply. That is the time to evaluate the materials produced by Bakelite Company. Their variety and versatility, besides solving many design problems, frequently are keys to design improvement.

The three examples on these pages employ, altogether, five different BAKELITE Brand Plastics and three fabrication techniques. They merely indicate the range of possibilities in the products made by Bakelite Company—the greatest variety of plastics and resins at one source. You can work with vinyls, epoxies, styrenes, phenolics, polyesters, silicones, polyethylenes, and impact styrenes. And you can call on the unsurpassed resources of Bakelite Company in applying them to your product.

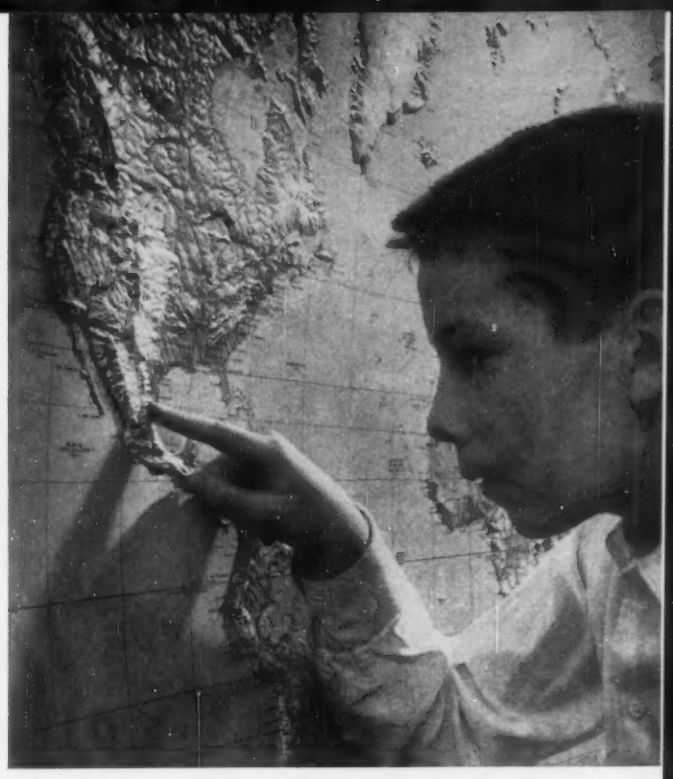
1 General-purpose and chemical-resistant phenolics both serve the SUNBEAM "Coffee Master"

In designing this utensil's handles and base, the chief considerations were good appearance and resistance to heat. BAKELITE Brand Phenolic BMG-5000 met both requirements at low cost. It demonstrates low thermal conductivity* even though it is a general-purpose material. It molds to a superb finish, without warpage or blisters.

The upper section of the "Coffee Master" is rimmed with a ring molded from BMG-2095. This is a chemical-resistant phenolic, since the part has to withstand contact with coffee grounds and hot fumes.

Bakelite Company produces three other classes of phenolics—heat-resistant, impact resistant, and electrical insulating types. For a complete description of all these products, write Dept. XV-103, requesting a copy of BAKELITE Molding News 24.

*Heat distortion temp. 330 deg. F. (D648-45T) (½ in.—264 psi)



2 Phenolic-paper lamination —first step in printed circuit construction

Miniaturization, sturdier construction, and fast assembly are among the advantages of printing electronic circuits on a laminated base. BAKELITE Brand Phenolic laminating varnishes, used in bonding the paper stock that forms the base, have kept pace with developments. In the MOTOROLA "Ranger" plated circuit for example, the lamination has to provide

A good base for bonding the copper . . .
High insulation resistance and low dielectric loss . . .
Translucent construction for checking circuit alignment from opposite sides . . .
Resistance to dip-soldering heat of 500 deg. F.

This particular circuit is made with a "hot punch" laminating varnish. Bakelite Company makes "cold punch" resins as well. If you are working with printed circuits, make sure that the base is fabricated with the resin varnish formulated to fit your need best. Technical information on Bakelite Company products can be obtained by writing Dept. XW-103.

3 Rigid vinyl sheets accurately reproduce designs as intricate as this

The realistic details of this three-dimensional relief map illustrates some of the design advantages of BAKELITE Brand Rigid Vinyl Sheets. Printed flat, the sheets are then softened by heat and shaped by vacuum-forming. Their dimensional stability helps keep printing in perfect register. Because production is fast and simple, costs are low. The map is durable and practical: *it weighs only a fraction as much as the usual 3-dimensional maps, and wipes clean in an instant.*

BAKELITE Brand Rigid Vinyl Sheets are available in a range of widths and thicknesses, clear transparent and colored translucent or opaque. Keep them in mind for dial faces, small parts, packages, fittings, and similar items that require accuracy, low cost, fast production. In service, these tough sheets will resist many chemicals, oils, moisture, and aging, and they can take a lot of handling. For further information, write Dept. XY-103.

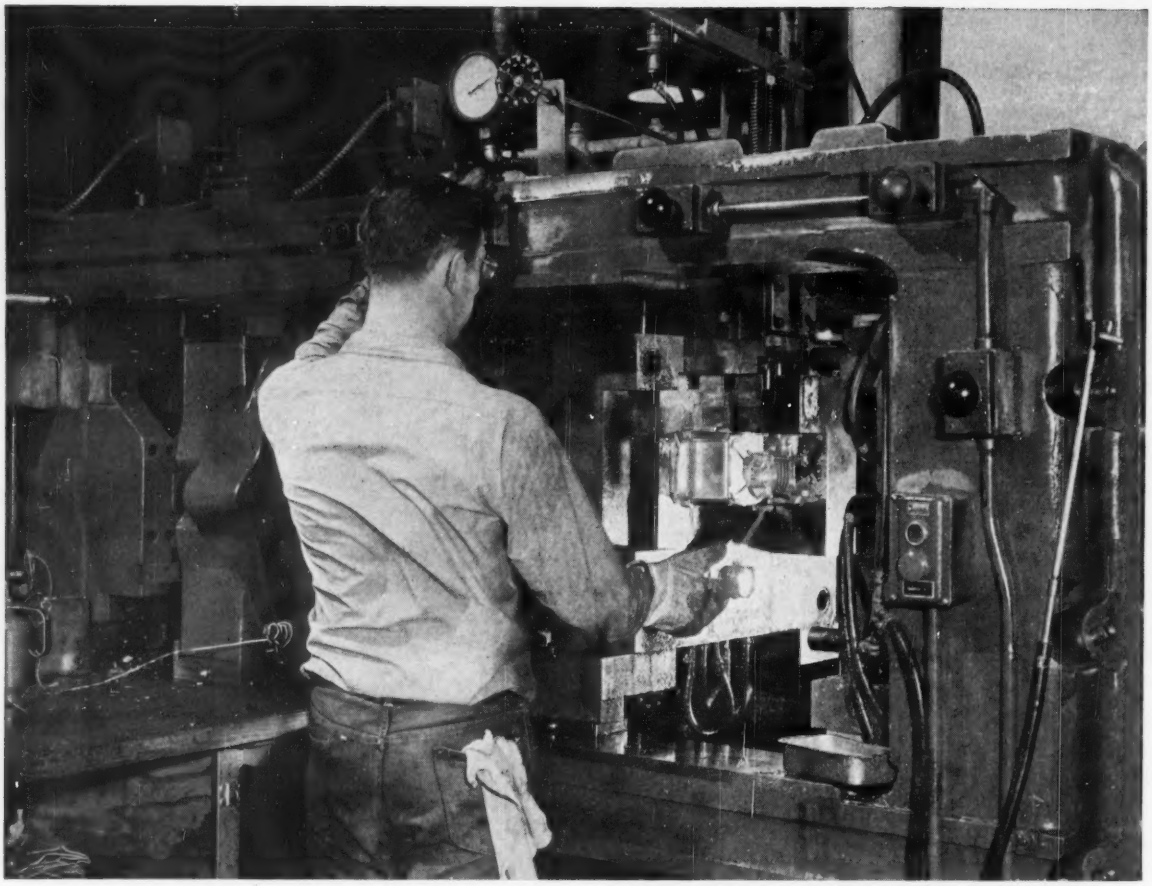
There's more to design with in **BAKELITE** BRAND **PLASTICS**

PHENOLICS • STYRENES • VINYLS • IMPACT STYRENES
POLYETHYLENES • POLYESTERS • EPOXIES • SILICONES

UNION CARBIDE

BAKELITE COMPANY, *Division of Union Carbide Corporation* UCC
30 E. 42nd St., New York 17, N.Y. The terms BAKELITE, UNION CARBIDE and the Trefoil Symbol are registered trade-marks of UCC.

Circle 473 on page 19



Cast Nickel Steel Frame heat treated to a minimum tensile strength of 100,000 pounds per square inch, yield strength of 80,000, provides properties needed to handle stretching action caused by 800-ton clamping force. This 40,000-pound die casting machine was built by Lester Engineering Company, Cleveland, Ohio.

Stretches with no permanent set...

High strength of nickel steel casting boosts life of repetitively stressed machine frame

The cast nickel steel frame on the die casting machine above accepts and recovers from a clamping force of 800 tons 100 times-an-hour... round the clock!

This punishing stress cycle caused Lester Engineering Company, builder of the machine, to discard four differently designed frames fabricated from mild steel. The firm then switched to a nickel steel frame casting which has proven completely dependable.

On the basis of this performance, Lester Engineering has standardized on cast nickel steel frames for its entire line of plastic molding and metallic die casting machines.

For high strength, toughness and impact resistance

Nickel steel castings offer a combination of properties that might be the key you have been looking for to improve performance and service life of your own machines and machine tools.

For a look-see on how you can take advantage of the properties of nickel steel castings, send for your copy of "Nickel Alloy Steel Castings in Industry."

And remember

INCO NICKEL ... brings you

INCO+SERVICES

Whenever you are looking for answers to your metal problems, all the information and help we can give you are yours for the asking. For instance ...

- **+ Corrosion Service**
- **+ High Temperature Service**
- **+ Casting Information**
- **+ Field Information Centers**
- **+ Technical Publications**

INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N.Y.

MACHINE DESIGN
October 3, 1957

Creativity or Success?

MUST an engineer choose between creativity and success? The dilemma of the hero in "Will Success Spoil Rock Hunter?" must strike many an engineer pretty close to home.

There are professions in which creativity and "success" are likely to be synonymous. But engineering and science don't seem to be among them, if success is defined as in the play—the attainment of wealth and position.

Recent University of Chicago studies among scientists employed in industry suggest that too often our question must be answered "yes." The more creative scientists, it was found, feel under no pressure of needing the quick approval of others. Thus, besides being liberal in social outlook and noncomformist in general behavior, they are also cautious and thorough rather than players of blind hunches.

But the more "successful" use their creativity as stepping stones. As they rise in an organization they begin conforming and soon trade creativity for success.

Truly this is a devastating commentary on industry's failure to reward creativity for itself. Creativeness is one of our most precious national assets. Engineering shortage or no shortage, there is never enough of it to go around.

A few forward-looking companies recognize the problem and make it possible for the creative engineer to reach good income level and position—the hallmarks of "success"—without having to trade away his creativity.

Is it too much to hope that this answer to our question will one day be the rule rather than the exception?

Colin Carmichael

EDITOR

Methods of Standardizing Engineering Reports

By EDWIN C. HUMMEL
Supervisor, Engineering Publications
Northrop Div.
Northrop Aircraft Inc.
Hawthorne, Calif.

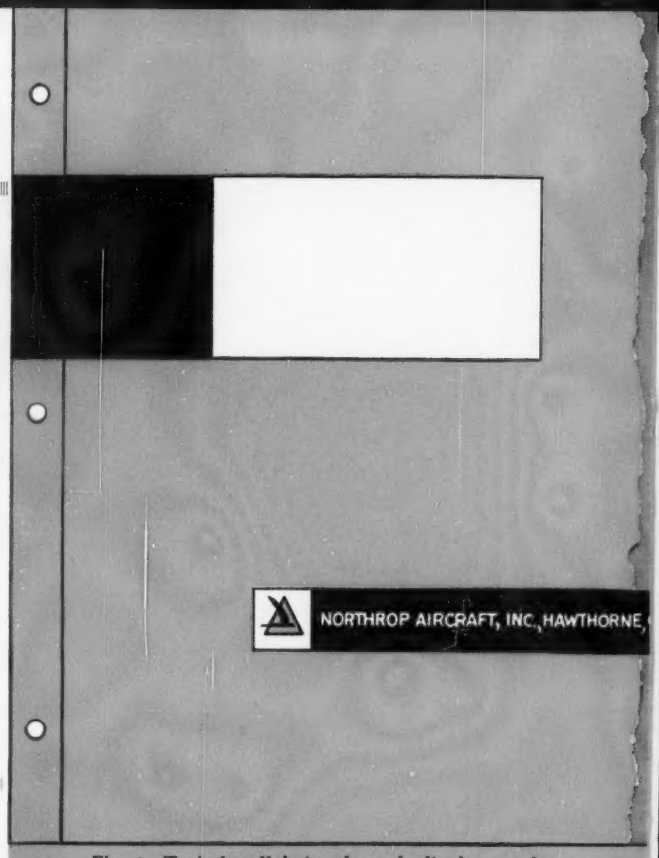


Fig. 1—Typical well-designed standardized cover for binding engineering reports. The die-cut window for exposing the report number title and date is 2⅜ by 4½ in. The opening is covered with a piece of clear acetate plastic glued on the underneath side.

Fig. 2—Below—Representative standardized engineering-report title page.

CLASSIFICATION

NORTHROP AIRCRAFT, INC.

HAWTHORNE, CALIFORNIA

SAMPLE TITLE PAGE

Report No. NAI-57-000

DESIGN OF THE OPTIMUM AIRCRAFT

1 June 1957

PREPARED BY

B. O. Smith

APPROVED BY

J. J. Doe, Supervisor
Jobs and Methods

A. B. Doaks, Chief
Test and Inspection

X. Z. Brown
Asst Chief Engineer
Test

REVISIONS

CHG. NO.	DATE	ENGR.	PAGES AFFECTED	REMARKS

CLASSIFICATION

105

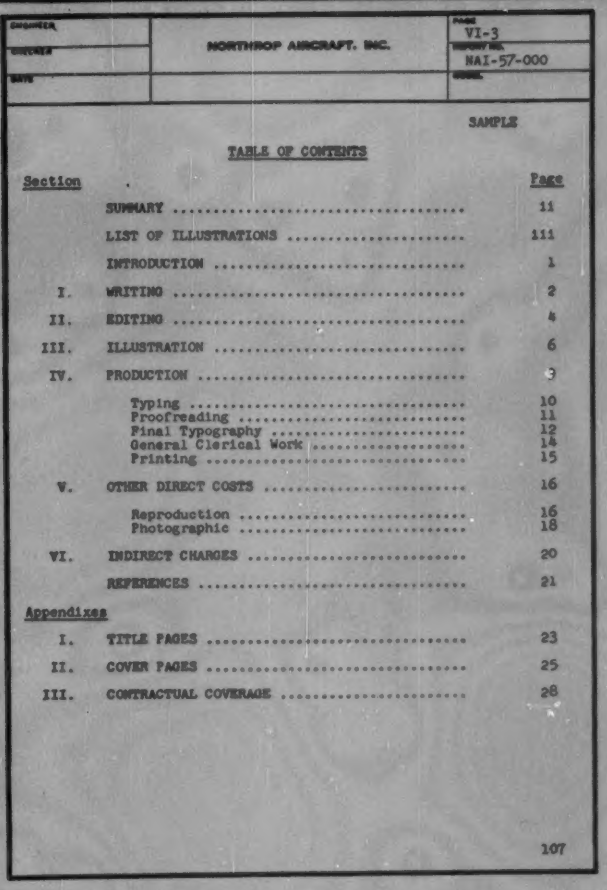
ENGINEERING department reports covering the design and development of new machines, equipment, instruments, etc., can be tremendously valuable to company management. If effectively written, engineering reports enable management to keep in close contact with engineering department projects, developments and accomplishments.

Of course, there is no question concerning the need and value of such reports to the engineering department itself, since they serve as a running record of technical and scientific knowledge and findings. Descriptions written by engineers of the design and operating characteristics of new products are also authoritative sources of information to purchasing, sales, advertising and other departments in a company.

In the aircraft industry, engineering reports represent a multimillion-dollar annual expenditure. In companies of any size, cost of engineering reports can be appreciable. Thus, engineering management should control reports closely. Reporting must be permitted and even encouraged, but engineering management must see that dollars allocated for design and development are not siphoned off in large quantities for reporting purposes.

▶ Why Report Standardization

With 3800 people in its engineering division, Northrop publishes a great many reports yearly



NORTHROP AIRCRAFT, INC.

PAGE VI-3

REPORT NO. NAI-57-000

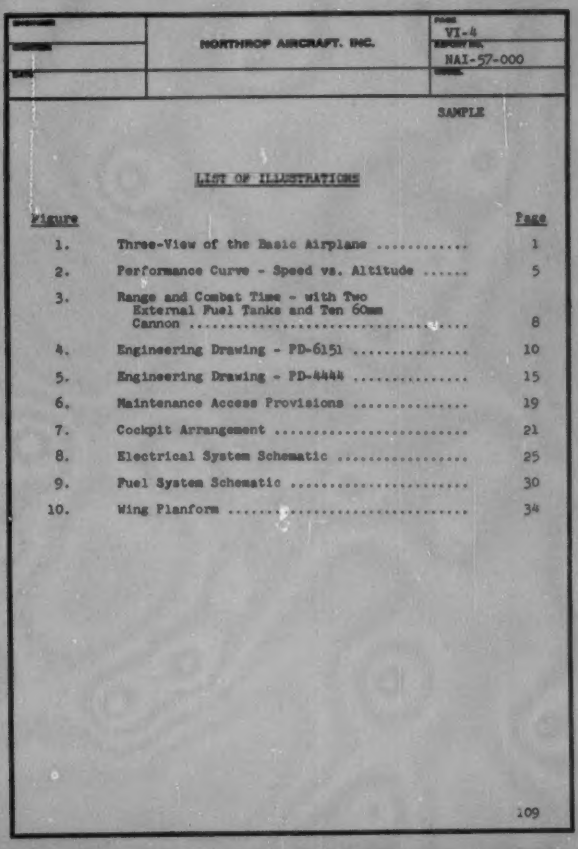
SAMPLE

TABLE OF CONTENTS

107

Fig. 3—Typical format for a table-of-contents page.

Fig. 4—Below—List-of-illustrations page.



NORTHROP AIRCRAFT, INC.

PAGE VI-4

REPORT NO. NAI-57-000

SAMPLE

LIST OF ILLUSTRATIONS

109

Basic standardization recommendations to simplify numbering, classifying, recording, indexing, preparing, approving, reproducing, and distributing engineering reports; size, format, and style considerations; methods of controlling cost without deterring report-writing incentive.

for its various projects. Each report represents a sizable expenditure and must be subjected to some form of economic control.

Many years ago, Northrop management decided that the answer to less costly reporting was to standardize engineering reports. This was done as quickly as the educative process allowed, with the happy and predictable result of reducing reporting costs substantially. Costs of such reports can be reduced in any company whose management is determined to adopt standardization requirements and support program objectives.

Standardization Requirements

The first step, of course, is to define in general terms requirements for numbering, classifying, recording and indexing, preparing, approving, reproducing, and distributing engineering reports. The use of numbers to identify and control engineering reports is the second step in report standardization. A centralized service section should be organized to control and issue such numbers. In a small company, the "section" may consist of no more than the part-time services of one engineer or supervisor. In any case, centralized control is the only way management can enforce report standardization.

Numerical Code: The engineering report should be given a simple, noncryptic number for identifi-

SAMPLE

SECTION I

REPORT FORMAT NO. 1

SECTION TITLES AND OTHER CENTERED TITLES

Section titles and other centered heads (INTRODUCTION, CONTENTS, SUMMARY, APPENDIX titles, etc.) are to be all caps, centered on the page, and underlined. When these headings are longer than one line, succeeding lines should be centered under first line. There should be at least four spaces above and three below each centered title, but no space between succeeding lines of the same title. On INTRODUCTION, CONTENTS pages, etc. which contain less than a full page of text, the body of the text and the title should be centered vertically on the page.

PRIME HEADS

Prime heads are to be all caps, underlined, and flush left. When a flush left head is longer than one line, succeeding lines are indented three spaces. Triple space before and after all prime heads.

First Minor Subtitles

First minor subtitles, under prime heads, are to be upper and lower case, underlined, flush left.

SECTION II

SAMPLE

REPORT FORMAT NO. 2

AIR FORCE REQUIREMENTS

Climatic Conditions

Military aircraft must be able to operate efficiently in any region of the world. They must function satisfactorily throughout the temperature range of -65°F to 160°F and in any climatic condition.

Durability

It is of paramount importance that the aircraft structure be designed to sustain a reasonable amount of battle damage without complete failure.

Ventilation and Drainage

Adequate ventilation shall be provided to dispose of any toxic, irritating, or explosive gases or liquids and any moisture that may condense on interior surfaces or enter through inadequately sealed openings.

Operation and Controls

All fighter aircraft enclosures shall be power operated unless specifically exempted from this requirement by the Procuring Agency.

Fig. 5—Four suggested formats for the main body of engineering reports. Formats 1 and 2 are designed for general reports, whereas formats 3 and 4 are more applicable to reports that require considerable detail or subordination.

SAMPLE

III. REPORT FORMAT NO. 3

A. Theoretical Investigations of the Underwater Rocket

1. Numerical Integration of Underwater Rocket Equations on I.B.M. Automatic Digital Computer

A report, describing the data accumulated on the underwater rocket launcher, considered previously, is still under preparation. Completion of this report has been delayed due to a calculation error. An additional report describing the method of calculation will be submitted in the near future.

A fuel for the underwater rocket is being investigated at this time.

2. The Calculation of the Stability

Corrections for the Willshire curve are still being computed. Furthermore, it is intended to integrate the two frictionless solutions of the Smith equation for smaller distances between nozzle and igniter.

3. Investigation of Bodies of Revolution

a. The 2-foot aluminum model containing a hexagonal rocket array is being built and will be ready for testing at the 40-foot-high turbulence tunnel at Chicago by 1 June 1956.

SAMPLE

4. REPORT FORMAT NO. 4

4.1 Air Force Requirements

4.1.1 Climatic Conditions: Military aircraft must be able to operate efficiently in any region of the world. They must function satisfactorily throughout the temperature range of -65°F to 160°F and in any climatic condition.

4.1.2 Durability: It is of paramount importance that the aircraft structure be designed to sustain a reasonable amount of battle damage without complete failure.

4.1.3 Ventilation and Drainage: Adequate ventilation shall be provided to dispose of any toxic, irritating, or explosive gases or liquids and any moisture that may condense on interior surfaces or enter through inadequately sealed openings.

4.1.4 Emergency Exits

4.1.4.1 Emergency exits must provide quick and easy abandonment of the aircraft in the air.

4.1.4.2 All emergency exits shall be quick opening and readily operable from the inside and from the outside of the aircraft.

4.1.5 Operation and Controls

4.1.5.1 All fighter aircraft enclosures shall be power operated unless specifically exempted from this requirement by the Procuring Agency.

4.1.5.2 Methods of jettisoning the enclosure shall be subject to the approval of the Procuring Agency before the 689 Board Inspection.

4.1.5.3 Clear-Vision Panel

4.1.5.3.1 When required by the type of model specification, a hinged panel shall be provided in the windshield and shall be capable of being latched in the open position.

4.1.5.3.2 The clear-vision panel shall be located so that the pilot must lean slightly to one side to obtain forward vision. The following types of panels may be used:

(a) Plate glass
(b) Plexiglas
(c) Acetate-type plastic

cation and reference. At Northrop, Arabic numbers are assigned consecutively, beginning with the number 1 and combined with a hyphenated prefix consisting of the last two numbers of the year of issue. For example, the first engineering report issued in 1957, regardless of project, would be identified by the number "57-1." This system has proved to be better for report control and reference than a modified Dewey-decimal system or other contrived number systems wherein the arrangement of the numbers indicates subject, project, department, and other cipherable elements of information.

This simplified numbering system reduces clerical labor. Determining and assigning Dewey-decimal or other complex numbers, and then logging the numbers compartmentally, requires more skill and clerical help which might be better utilized for other work. A simple numbering system also reduces the possibility of misnumbering, duplication, and errors leading to loss of confidence in reaching standardization objectives.

It is equally important that all reporting departments obtain numbers from the service agency and then use the numbers correctly, without deviation. There is no economic justification for any department to exercise independent control.

Standardized Art Covers

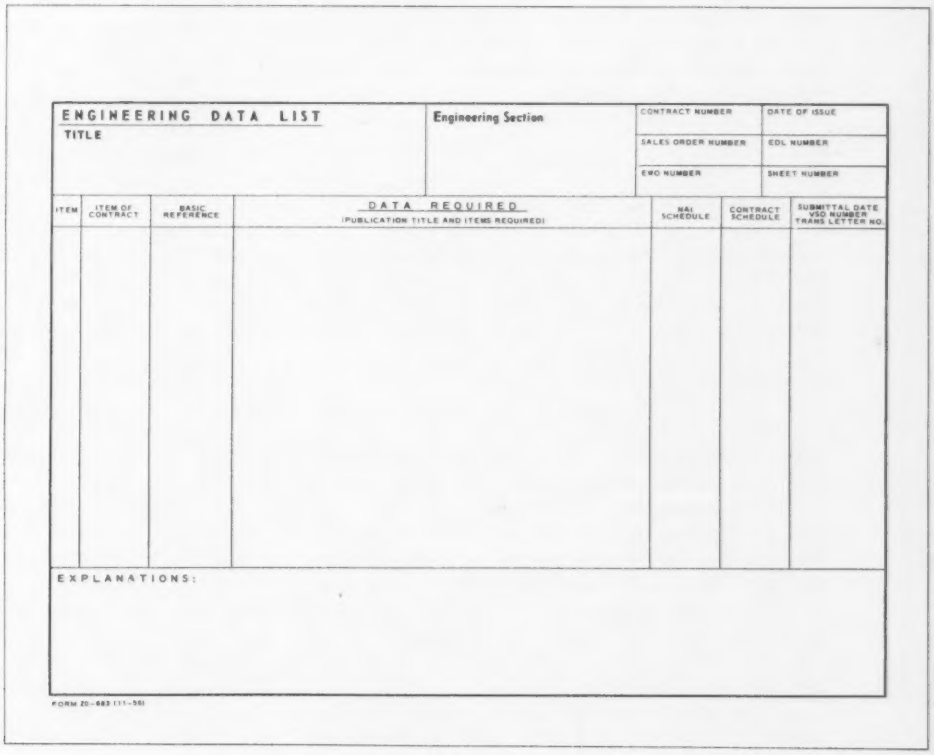
Regardless of number of pages, the report should be bound in a uniform and distinctive cover. By repeated use of the same cover, the company is soon associated with its literature. A well-designed cover can help increase company prestige. An elaborate cover is not the determining factor; a paper cover with a good design is generally superior to costlier covers on the basis of both personal reactions and dollar savings. For example, Northrop uses a plain, conservatively designed cover printed on orange-colored stock, and containing a die-cut window, Fig. 1. The window allows advance printing of the covers in large quantities. In companies the size of Northrop a considerable amount of money can be saved through mill purchase of cover stock in carload lots, through reduced and concentrated press time, and through elimination of extra steps in handling. Smaller companies can save, too, by similar techniques.

Format and Style

Engineering reports require a certain amount of standardization of format and style to be effective.

The format of the title page, Fig. 2, with the report title mated to the window in the cover, Fig. 1, should be identical in each report. A typical table-of-contents page is shown in Fig. 3, and Fig. 4 shows a list-of-illustrations page. A more or less standardized format for these pages is recommended, too.

In general, the main text of engineering reports should be confined to one of not more than four



ENGINEERING DATA LIST

TITLE

Engineering Section

CONTRACT NUMBER | DATE OF ISSUE

SALES ORDER NUMBER | EDL NUMBER

EWO NUMBER | SHEET NUMBER

ITEM	ITEM OF CONTRACT	BASIC REFERENCE	DATA REQUIRED (PUBLICATION TITLE AND ITEMS REQUIRED)	NAI SCHEDULE	CONTRACT SCHEDULE	SUBMITTAL DATE VSO NUMBER TRANS LETTER NO.

EXPLANATIONS:

FORM 20-683 (11-56)

Fig. 6 — Standard engineering data list used at Northrop. Technical specialists analyze contracts to determine the number of required reports, which are cataloged by title and delivery date on this sheet.

formats, depending upon the type of report. Selection of the format rests with the engineer. In Fig. 5 are sample formats found useful at Northrop.

There are several reasons for limiting the number of formats available to the reporting engineer. First, most people find that a familiar, standardized format provides easier understanding of a report. Second, publication preparation and reproduction by clerical and service personnel can be improved through simplification. Third, an approved format can be used as a guide by the engineer in the preparation of his report. There is also the company prestige consideration of having uniform reports.

In Fig. 5, formats 1 and 2 are designed for reports of a general nature. Formats 3 and 4 are particularly useful for highly detailed reports or reports requiring a large amount of subordination. Information contained in Section I of each format illustrated in Fig. 5 actually concerns the preparation of reports; however, the text in the other sections is nonsense used to show the format.

Need for Stylebook: If allowances are made for the personal motivation and training of reporting engineers, style can be standardized successfully. Organization of material and rhetoric are left up to the engineer. A stylebook, incorporating management desires in this respect, should be issued to the engineering departments. In small companies a "stylebook" may consist of only a two or three-page interoffice memo on suggested symbols and abbreviations for engineering terms plus a short list of approved word spellings and usages. The stylebook does not have to be followed to the letter, but every effort should be made to encourage such conformity. However, engineers who deviate radically must be asked to rewrite or edit the report so as to meet minimum report acceptability.

Reproduction Cost Factors

Periodically, it is necessary to remind reporting engineers of the need to observe economical practices. A fundamental knowledge of printing and reproduction processes can save time and material. Lack of such knowledge is often responsible for delays in production and costly mistakes.

At the time of assigning the report number, the reports section should establish with the engineer a preparation method for the least expensive reproduction on the basis of distribution and quality requirements. This service may be augmented by including in the stylebook a detailed description of each reproduction process available and selection recommendations. This service is in an area where professional knowledge in applied technology, even at the expense of bringing in an expert from the printing trade, can result in substantial savings.

So far as the reproduction processes are concerned, every effort should be made to discourage requests for offset printing; in nine cases out of ten, ozalid reproductions in blueline or blackline will be more economical and will still meet requirements.

Instituting the Program

To standardize reports successfully, engineers in direct charge of projects or programs must be concerned with report economies as well as with design and development. Co-operation by these "middle-management" engineers must be on an active and interested basis. Their responsibility is great, for the control of reports lies within their authority.

Distribution Lists: The fringe report that serves no apparent purpose except that of authorship should be eliminated. This is mandatory where a single project may produce several engineering reports a day.

At Northrop this control is exercised through the use of a distribution list which accompanies the report through cosignatories with power of rejection. Fortunately, in most companies senior engineers are seldom guilty of nonessential reporting. If nonessential reporting is a problem, however, a program of inspection of reporting needs may be initiated.

Engineering Data Lists: At Northrop, the project offices and the reports section goes into action at the time of contract placement. The contract is analyzed by technical specialists in the reports service section so that required reports can be cataloged by title and delivery date, for reference and performance surveillance, on an engineering data list, Fig. 6. Copies of the list are sent to the project office for approval and then to the responsible department for compliance. The engineering department must prepare the report or, if the company has a publications department, ask to have it written. This should be determined on the basis of technical complexities, with the understanding that highly technical reports are best written by the engineer.

If the need arises for a report not on the engineering data list, or when ready to begin a listed engineering report, the engineer must ask the reports section for a report number. The number is assigned, contract or target dates for the report are confirmed or established, and the most economical method of reproduction is determined.

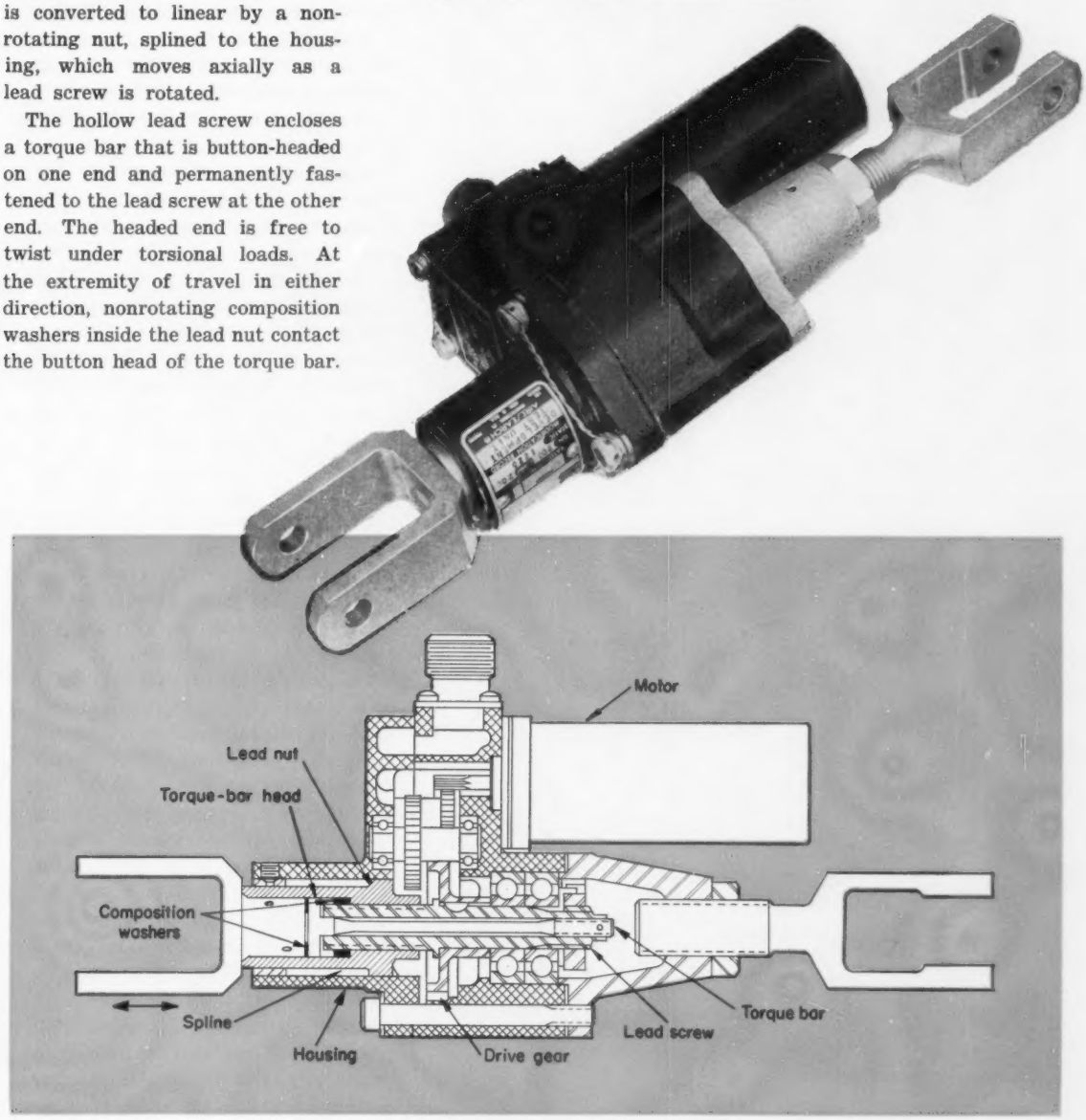
Final Approval: The report, when written to the engineer's satisfaction and approved by his supervisor, is typed for final reproduction on the necessary masters. The masters are routed, along with the distribution list, through the reports service section to the governing project office for approval. After approval, the masters and signed distribution list are returned to the reports section for reproduction of the necessary copies and distribution.

scanning the field for *ideas*

Torsional braking of power-screw assembly provides nonjamming stops for axially moving nut member while under load. In a linear actuator developed by Air-Research Mfg. Co., rotary motion is converted to linear by a nonrotating nut, splined to the housing, which moves axially as a lead screw is rotated.

The hollow lead screw encloses a torque bar that is button-headed on one end and permanently fastened to the lead screw at the other end. The headed end is free to twist under torsional loads. At the extremity of travel in either direction, nonrotating composition washers inside the lead nut contact the button head of the torque bar. The washers brake the head of the torque bar, causing it to twist and shorten in length under the torque from its driven end, stalling the drive.

Release is effected by reversing the drive motor. The torque bar untwists, regaining its orginal length and disengaging the braking surface of the composition washer.



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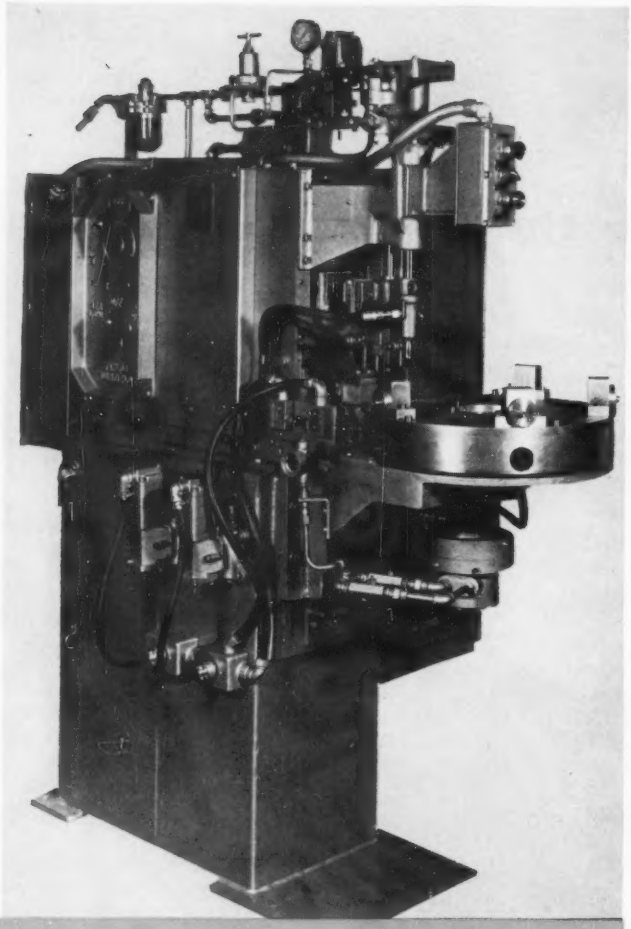
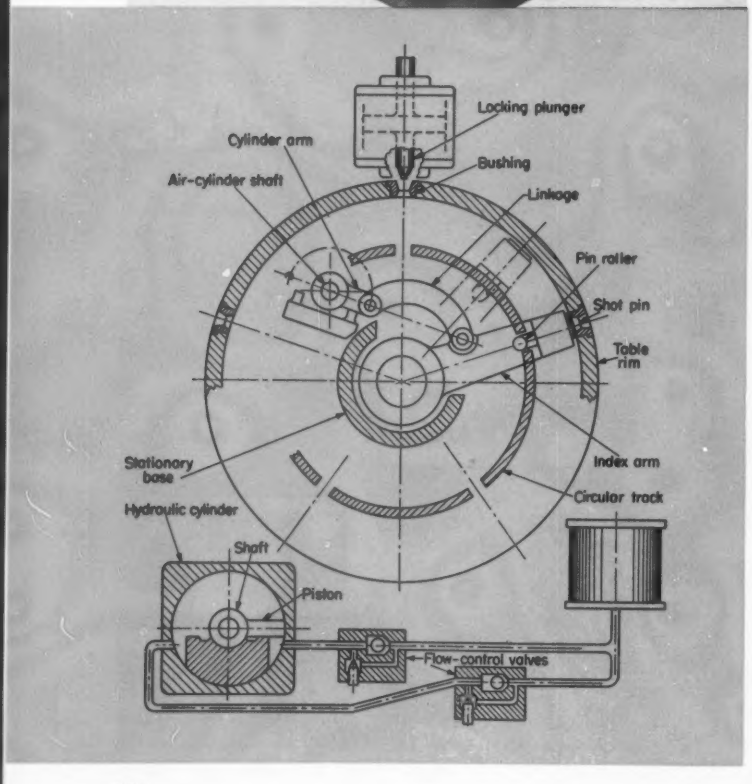


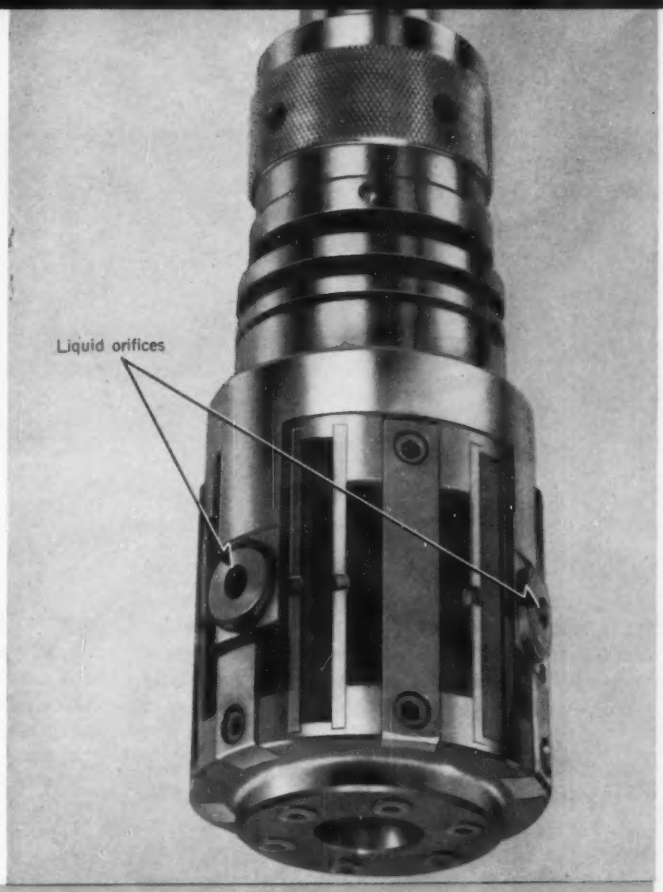


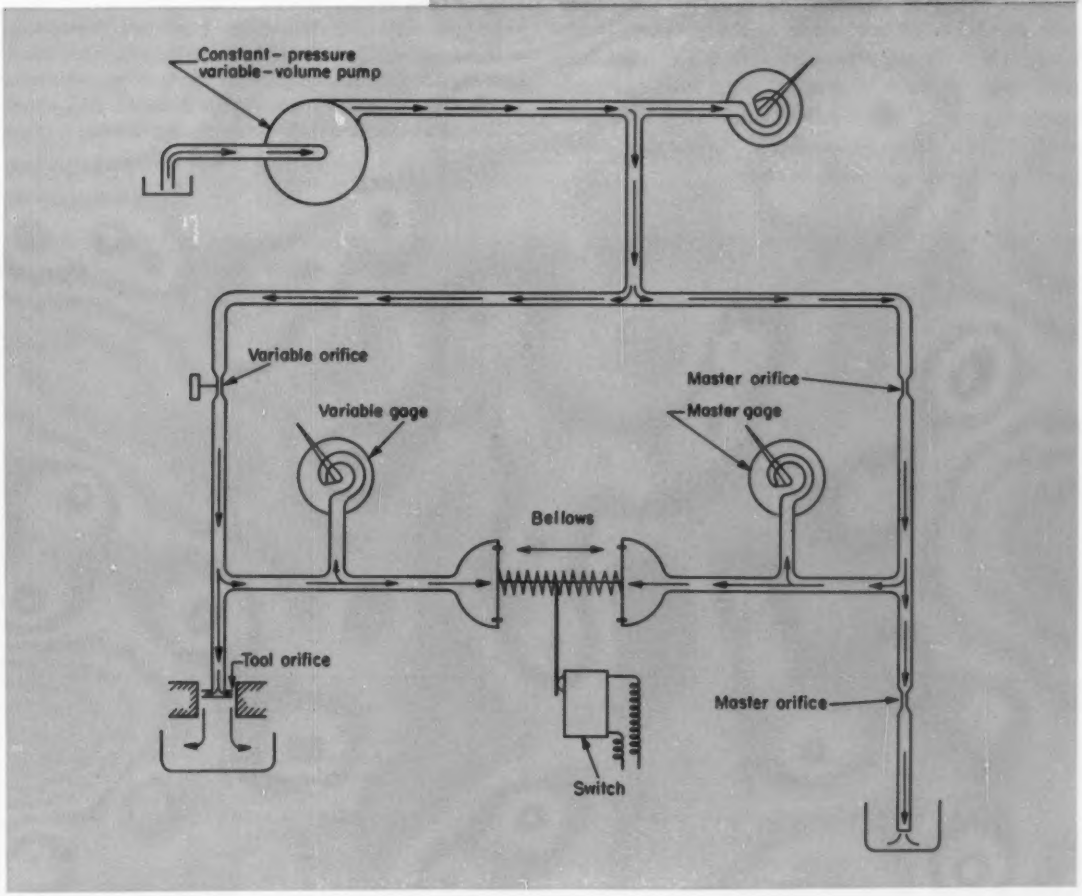
Air-oil indexing provides control of motion and cycle time, and eliminates bounce. In an indexing table designed by Taylor-Winfield, an oscillating rotary-type air cylinder imparts harmonic relative motion to the table top through a four-bar linkage. A hydraulic snubber arrangement permits control of indexing time and eliminates air-cylinder bounce.

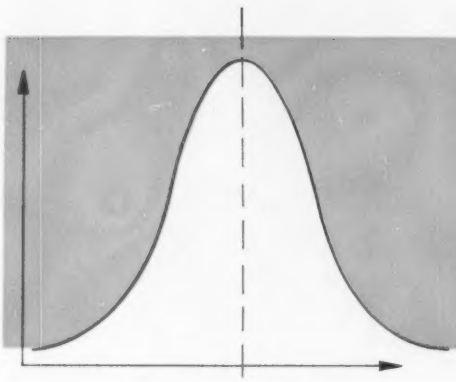
The rotary air-hydraulic cylinder is mounted on the base of the table. Indexing motion is imparted to the table by a linkage joining the projecting cylinder arm and the indexing arm. The end of the index arm contains a spring-loaded shot pin that engages a double-tapered bushing in the table rim. At the end of the indexing movement, an air-operated plunger enters the bushing from the outside of the table. This plunger forces the shot pin on the indexing arm out of the bushing and locks the table against rotation. As the shot pin is forced from the bushing, a roller on the pin engages a circular track on the underside of the table, permitting the index arm to return to its original position with the pin held clear of the table rim.

The rotary air-hydraulic cylinder is a single unit, with the air and hydraulic chambers separated but of identical construction. The rotary "pistons" in the two sections are mounted on a common shaft. When air is admitted into the air section, it causes 180-degree rotation of the pistons. This forces oil in the hydraulic section out of the cylinder and through an adjustable speed-control valve. On the reverse stroke, oil is forced out the opposite cylinder port and through another valve. Adjustment of the two speed-control valves regulates the cycle time for both index and return strokes.

Built-in fluid gaging system provides automatic control of metal removal in machine-tool cutting operations. The system constantly measures the work during the cutting operation, stopping the machine when a predetermined size is reached. In the liquid-honing system developed by Barnes Drill Co., the cutting fluid is pumped through metering orifices in the tool directly against the wall of the hole being finished. As honing progresses, the distance between the orifice in the tool and the wall of the hole increases, reducing the fluid back pressure. As this pressure decreases, it causes expansion of a bellows. When the cutting-fluid back pressure has dropped to the pressure of a master gage, the bellows actuates an electric switch, stopping the cutting operation.







PREDICTING

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The ability to estimate the results of a design decision in the preliminary stages as well as in the production stage of a project is a useful and often necessary skill. This article shows a general method for evaluating data about possible design deficiencies and the corresponding risk taken when a unit is not performing satisfactorily.

A design deficiency is discovered through an analysis of the possible variations of the environment in which a product will be subjected along with the inherent variations in the product itself. Intuitively it is easy to associate high reliability with high product "strength" and low environmental "stress." The method of arriving at a numerical reliability estimate is developed from basic mathematical considerations.

WHEN a series of products are manufactured that are supposed to be identical, each unit will vary from the next, even with the closest quality control. Not every plastic part has the same tensile strength, or every cylinder bore the same dimension, or every bearing the same hardness. Use of tolerance limits demonstrates the acceptance of this condition.

Generally, product variability is a continuous curve. A typical frequency distribution curve of product strength is shown in Fig. 1.

In this article, distribution of product variability will be called the strength distribution. The word "strength" implies only resistance to an environment and not merely physical strength.

When a component or machine is put into service

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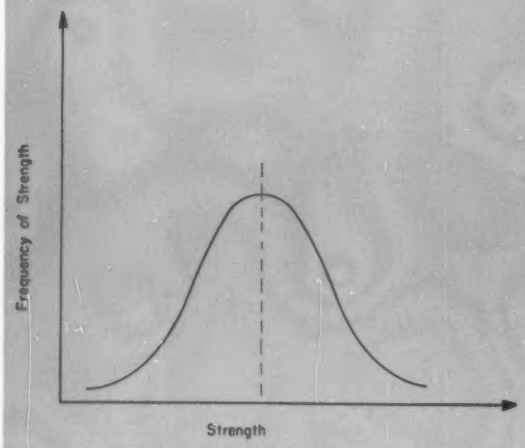


Fig. 1 — Frequency distribution of the "strength" of a typical product—a part, a material or a complete machine. The abscissa is the variable of interest, and the ordinate is the fraction of units that possess this variation.

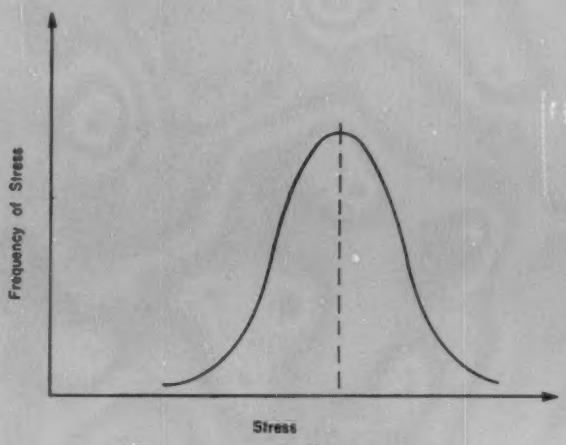


Fig. 2—Unimodal frequency distribution of the "stress" of an environment. The variable of interest is the abscissa, and the ordinate represents the fraction of times this variable will occur.

PERFORMANCE FAILURES

. . . by statistical evaluation of product "strength" variability compared with expected variability of the environmental "stress."

under the conditions for which it is designed, its environment is bound to be variable. The environment usually has one average condition or stress it exerts on the product, as well as less-frequent conditions which are either harsher or milder. The most common environment encountered is called the mode. A distribution that has only one most-frequent condition is called unimodal. Fig. 2 is a typical representation of a unimodal service distribution.

Design Reliability: Standard design procedure is to assume or calculate a point in the environment distribution—usually a point in the severe range—and apply a margin of safety. This procedure will make certain that the average strength of the design is definitely above the more severe stresses to which the design will be subjected, Fig. 3.

When the mean point of the expected environment is used as a base for the design, a larger allowance is made to bring the average strength of the design above the severe stresses. This factor is often called the factor of safety. Since standard nomenclature does not show any difference between margin of safety and factor of safety, a short digression will be taken to illustrate the difference between the two terms.

Fig. 4 is a general representation of the various "stress" levels encountered in design work. The distance between the mean design strength and the upper or mean environment stress determines the service reliability of the design, or the unreliability. Any overlap of the two distributions means that there is some chance for the environmental stress to exceed the strength of the product. As the overlap increases in Fig. 4, more units will fail, and individual reliability will drop. Reliability is the probability that a unit will not fail when

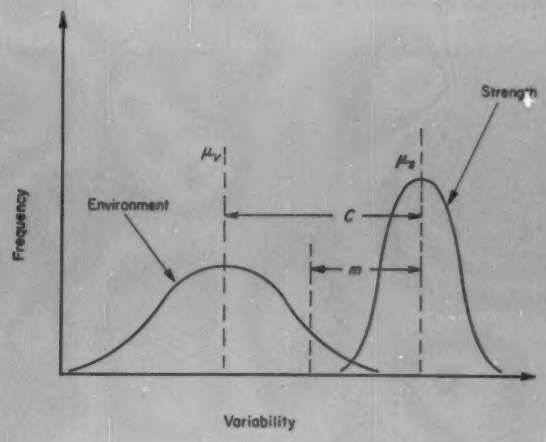


Fig. 3—Product "strength" distribution with overlapping environmental "stress." *C* is the factor of safety, and *m* is the margin of safety.

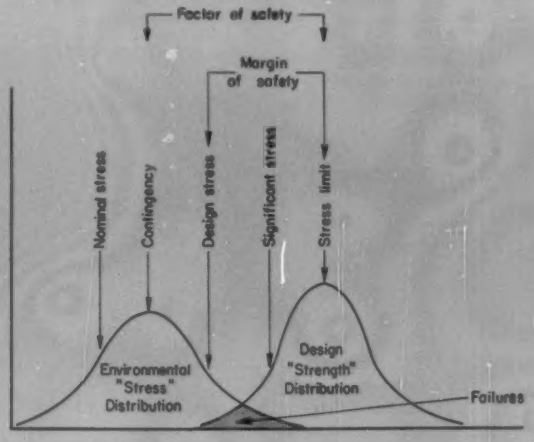


Fig. 4—Levels of "stress," the variable of interest, and the point of intersection with the strength and stress distributions. A mean or contingency environment is one starting point for making a design stronger than the environment. Another point is the margin of safety which starts with a severe environment. If either the margin or factor of safety is specified, the other is automatically determined.

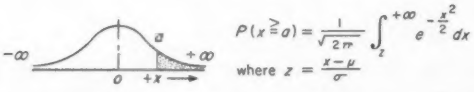
placed in the environment for which it was designed.

Another type of reliability more familiar to inspection departments in companies is "factory reliability." This is the quality control exercised on the product while it is in the factory. Inspection has the purpose of marking a unit as a defective before it leaves the factory in situations where pieces are missing from an assembly.

The overall reliability of a unit is the product of factory quality and design reliability, or

$$R_t = R_f R_d \tag{1}$$

Table 1—Areas Under the Normal Curve from z to ∞



z	0.00	0.02	0.04	0.06	0.08
0.1	0.4602	0.4522	0.444	0.4364	0.4286
0.5	0.3085	0.3015	0.2946	0.2877	0.2810
1.0	0.1587	0.1539	0.1492	0.1446	0.1401
1.5	0.0668	0.0643	0.0618	0.0594	0.0571
1.6	0.0548	0.0526	0.0505	0.0485	0.0465
2.0	0.0228	0.0217	0.0207	0.0197	0.0188
2.5	0.00621	0.00587	0.00554	0.00523	0.00404
3.0	0.00135	0.00068	0.00033	0.000159	0.0000723

Table 2—Frequency Distribution of Environmental Stress Data in Example

Load, F (lb)	Frequency of Occurrence of Loads in First-Column Range	$V_{(s)}$—Probability of Upper F Value or Less
Less than 56,000	1/4	1/4
56,000 to 100,000	4/10	13/20
100,000 to 120,000	2/10	17/20
120,000 to 140,000	1/10	19/20
140,000 to 150,000	1/20	1

Nomenclature

A = Area
a = A particular value of x
C = Factor of safety
e = Base of Naperian logarithms, approx 2.7183
F = Load
$H = F/A$ = Stress
m = Margin of safety
N = Number of cycles
P = Probability value
R_d = Design reliability
R_f = Factory reliability
R_s = Service or performance reliability
R_t = Overall reliability
R_{ts} = Overall service or performance reliability
S = Strength
$S(x)$ = Cumulative "strength" function of x
$s(x)$ = Frequency "strength" function of x
$V(x)$ = Cumulative environmental "stress" function of x
$v(x)$ = Frequency environmental "stress" function of x
$z = (x - \mu)/\sigma$
μ = Mean value of a distribution
σ = Standard deviation from the mean value of a distribution

where R_t = overall reliability, R_f = factory reliability, and R_d = design reliability.

This article is concerned with design or service reliability only. Since all manufactured products have variations and all environments are likewise variable, the methods of estimating this service reliability have great generality.

The General Case: To set the stage for solution of the general case, a few ideas will be repeated.

Every unit manufactured contains some innate differences from other units. A distribution curve for the frequency of occurrence of these differences can usually be represented by a mean value μ and a measure of variation—usually the standard deviation, σ. A normal or gaussian distribution[1] will be used to illustrate the numerical examples, but any distribution can be used. Let $s(x)$ represent the strength distribution along the x axis. The probability that the strength, which is the resistance to environment, is between x and $x + dx$ is

$$P(x \leq s \leq x + dx) = s(x)dx \tag{2}$$

Similarly the variation of the environment can be represented by a distribution curve showing stresses and the frequency of their occurrence. Let $V(x)$ represent the environment distribution along the x axis. The probability that the stress does not exceed x is

$$P(v \leq x) = \int_0^x v(x)dx \tag{3}$$

The reliability or probability of the strength being between x and $x + dx$, and the stress not exceeding this value is

$$s(x)dx \int_0^x v(x)dx$$

When this expression is summed over all possible values of x, the overall service reliability, R_s, is

[1]References are tabulated at end of article.

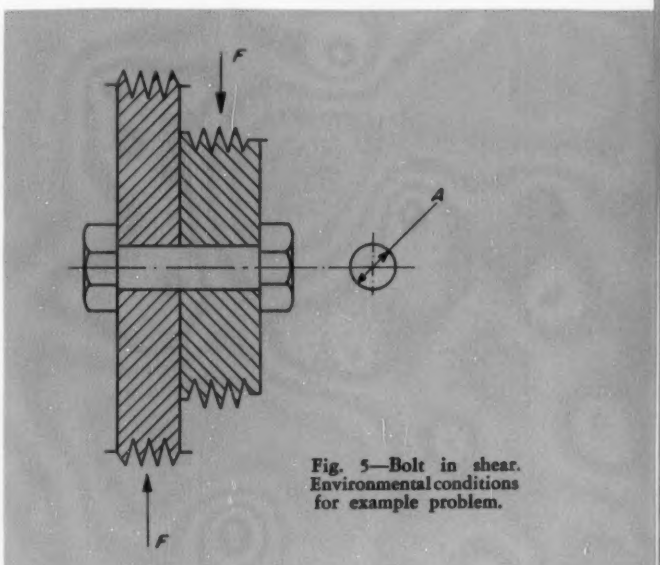


Fig. 5—Bolt in shear. Environmental conditions for example problem.

$$R_s = \int_0^\infty \left[\int_0^x v(x)dx \right] s(x)dx \qquad (4)$$

If the distributions are known (a factor discussed later), this integral can be evaluated. A good graphical method can be employed by substituting Equations 5 and 7 listed below into Equation 4 to get Equation 8

$$V(x) = \int_0^x v(x)dx \qquad (5)$$

Equation 8 is the area under a curve of V versus S, both of which are functions of x.

Normal Probability Integral: Before proceeding to an example problem, brief mention of normal probability integral will be made at this point.

In many cases where variables arise from chance about some average position, they do so in a random manner described by the normal probability integral. The equation for this integral is

$$S(x) = \int_0^x s(x)dx \qquad (6)$$

$$dS(x)/dx = s(x) \qquad (7)$$

$$R_s = \int_0^1 V(x)dS(x) = \int_0^1 VdS \qquad (8)$$

$$P(x \leq a) = \int_{-\infty}^{a} \frac{1}{\sqrt{2\pi}\,\sigma} e^{-0.5(x-\mu/\sigma)^2}\,dx \qquad (9)$$

where μ is the average value and σ is the standard deviation. This is the probability of x taking on values from $-\infty$ to a. Fortunately this integral is readily handled by some simple manipulations. The result is called the standard form of the normal probability integral, or

$$P(x \leq a) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{(a-\mu)/\sigma} e^{-0.5x^2}\,dx \qquad (10)$$

Example: Assume that a bolt is subjected to a shear force F as shown in Fig. 5. The resulting stress is determined from $H = F/A$ where A is the cross-sectional area of the bolt. The bolt material is SAE 1035 steel with an elastic limit of 65,000 psi and an ultimate strength of 96,000 psi. The expected design force F is 100,000 lb. The minimum area of bolt is 100,000/96,000 = 1.04 in. Working from the elastic limit with a factor of safety of 1.5, the area is 1.5 (100,000/65,000) = 2.3 in. This means the bolt is designed to withstand a force of 2.3 (96,000) = 220,000 lb. But if the elastic limit is exceeded, a permanent set will ruin the joint. Thus the maximum load for failure is really 2.3 (65,000) = 150,000 lb. The uncertainty of the material strength is ± 2600 psi, depending on the quenching temperature and the conditions of the quench. This varies the bolt strength by ±2.3 (2600) = ±6000 lb. If a normal distribution of strength between 150,000 ±6000 is assumed, the standard deviation is 6000/2 = 3000 lb (assuming two standard deviations). The probability of the strength being between 0 and x is

$$S(x) = \frac{1}{\sqrt{2\pi}} \int_0^{\frac{x-150,000}{3000}} e^{-x^2/2}\,dx$$

If it is assumed that load x varies between 0 and 155,000 lb, the value of $V(x)$ is

$$S(x) = \frac{1}{\sqrt{2\pi}} \int_0^{\frac{155,000-150,000}{3000}=1.67} e^{-x^2/2}\,dx$$

Numerous tables have been prepared giving the value of this function, the only parameter being the upper limit of the integral. In this case it is $z = 1.67$. An excerpt of a standard table, Table 1, shows that the value of the integral is 0.9520. At

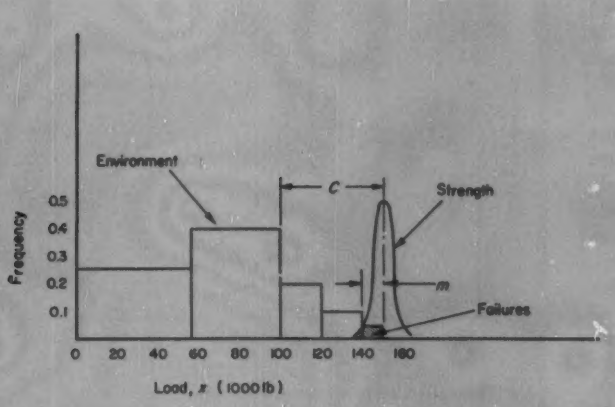


Fig. 6—Frequency distributions for bolt strength and environment load. Factor of safety $C = 150,000/100,000 = 1.5$. Margin of safety $m \approx 150,000/140,000 = 1.1$. Only about 5 per cent of the possible loads exceed 140,000 lb. In statistical terms, the area under both curves is unity.

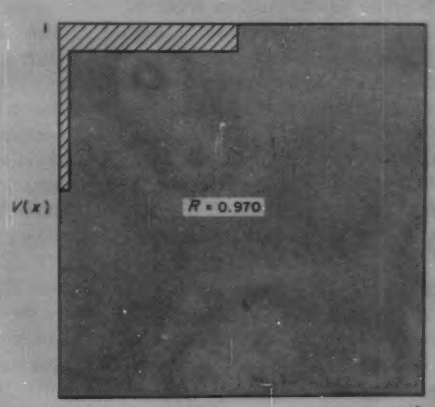


Fig. 7—Graphical solution of integral of $V\,dS$ between 0 and 1. Reliability equals the shaded area or 0.970.

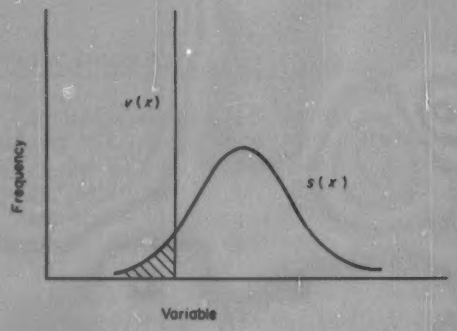


Fig. 8—Fixed environment. The straight line represents the only stress the environment can take. Shaded area is the fraction of units below the minimum strength, and the rest of the area is the design reliability.

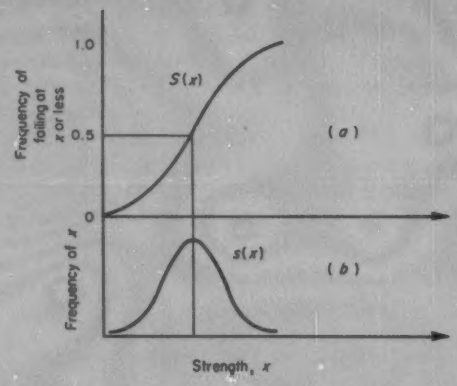


Fig. 9—Cumulative frequency distribution is shown in *a*. The ordinate is the fraction of units or less that will fail at the point of stress on the curve. Test results, when plotted, should give a similar curve where the ordinate is the fraction which fail at the stress point or any higher stress. In *b* is the derivative curve of cumulative frequency distribution.

$z = 1.67$ the value read is 0.0475—after interpolation. This is from $+\infty$ to 155,000. Since the area desired extends from $-\infty$ to 155,000, the value 0.0475 must be subtracted from 1. Of course, the area total under the normal probability curve from $-\infty$ to $+\infty$ is 1. The probability of x being between 0 and 155,000 is therefore 0.9520.

If actual tests on the expected environment give the frequency distribution shown in Table 2, the values of $V(x)$ can be read from the last column.

Table 3 lists values of $S(x)$ for the same loads that appear in Table 2. A plot $v(x)$ values from Table 2 and $s(x)$ values from Table 3 are made in Fig. 6.

In Fig. 7 is the graphical representation of $V(x)$ versus $S(x)$. The area under the curve is 0.97 which is the reliability of the bolt. This means that 3 out of 100 will fail because of a design deficiency.

Special Case: Sometimes the variability of the environment is practically nil. A straight line can be used to represent this situation, Fig. 8. The shaded area to the left or below the fixed environment is the measure of the fraction of units whose strength is less than the environment. This shaded area also depicts the probability of a unit failing. The area to the right or above the line is the reliability of the product. If the variability of the product is nil, the same reasoning can be applied. The reliability is the stress region below or less than the fixed strength.

Repeated Environments: To give a satisfactory performance a product, which will experience repeated environments like a loaded turning shaft, must be built with a special design—in this case a fatigue design. The new design must effectively raise the reliability. This is necessary because the reliability decreases exponentially with the number of repetitions of an environment.

$$R_{t_s} = R_s^N \qquad (11)$$

where R_{t_s} = overall service reliability, R_s = one-cycle reliability, and N = number of cycles. If R_s is 0.99 and N is 100, the overall reliability is $0.99^{\prime\prime} = 0.368$, while an R_s of 0.98 has a reliability of $0.98^{\prime\prime} = 0.133$. A 1.01 per cent decrease in the one-cycle reliability induces a 64 per cent decrease in the overall value.

Generally, if only a few repetitions of an environment are anticipated, i.e., dropping a casting in transportation, and if the effects are independent, then Equation 11 holds. In the case of a loaded turning shaft, the initial environment would be one of repeated stresses already mentioned, and the strength distribution would be resistance to stress cycles. The condition of interest is made the basis for the primary strength and stress distributions.

As an example, suppose the load in the problem given in the previous section under the general case is to be removed semiannually during servicing of the machine. And when it is replaced, it can assume a different value according to the frequency distribution. At the end of 4 years the

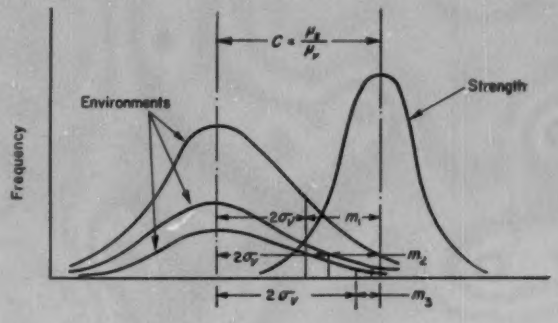


Fig. 10—Effects on margin of safety, m, with dispersion of environment. The extreme environmental point determines where margin of safety starts and includes about 95 per cent of area of each plotted environment curve. As this extreme point moves closer to the mean strength the dispersion increases.

chance that the joint is still effective is $0.97^8 = 0.784$.

Multicomponent Reliability: The treatment of this article has been on the general nature of service reliability. Often the individual components that make up a product are the determining factors on which a reliability estimate is based. When the complete unit cannot easily be tested to find the overall strength distribution, it is necessary to resort to methods of combining the individual component reliabilities. The frequency distribution for each component must be found. Then at every stress, the probability of the complete unit failing is the probability that at least one component fails. If μ_{ij} is the probability of the ith component failing in the jth condition, the chance of at least one out of n components failing is $1 - (1 - \mu_{1j})(1 - \mu_{2j}) \ldots\ldots (1 - \mu_{nj})$. A curve of the failure probability for all j conditions is the necessary cumulative strength distribution for the complete unit.

Assume that the joint for the numerical problem is poorly manufactured, and the upper plate has a probability of 0.98 of developing a crack and the lower plate a probability of 0.96. Under these conditions, the overall probability of the joint failing is $1 - 0.98\ (0.97)\ (0.96)$ or $1 - 0.91$. Or the reliability is now $1 - 0.09 = 91$ per cent. The 0.97 value is the bolt reliability, 0.96 is lower plate reliability, and 0.98 is upper plate reliability.

Determination of Distributions: It is often necessary to resort to a test to find the frequency distribution of strengths of a manufactured product. If the unit is designed to operate far above its expected environment, its chance of failing at any stress in the service range is very low. A large number of samples would be required to find what percentage fails under low stress. The best procedure is to test the product in the region where it is expected to fail and, by determining its variability about its mean position, extrapolate the distribution to other regions.

A plotted curve of the fraction of units that fail versus the stress point they failed at is a cumulative frequency distribution. The load distribution $V\ (x)$ given in the numerical example is a sample of a test result which determines the distribution of loads. It tells the fraction that will fail at a certain stress value or larger. The reasoning is that if n_1 units fail at x_1 then n_1 will surely fail at x_2 if x_2 is greater than x_1, Fig. 9.

The cumulative frequency curve in Fig. 9*a* is the integral of the distribution curve in Fig. 9*b*. There are ways of moving from the test result curve of Fig. 9*a* to the curve that represents the variability of the units. One way is to call the 50 per cent point the mean, μ_s, and assume a normal distribution. By using different standard deviations, cumulative frequency curves can be plotted, Fig. 9*a*.

Since the graphical solution to the general method requires only the cumulative distribution, the reliability could be calculated directly from the test results—with any necessary extension into untested regions.

The important point to remember is that by testing in a region where results or failures are expected, a smaller number of samples can be used to supply the necessary raw data. This is extremely valuable where destructive tests on expensive items are required.

Table 3—Frequency Distribution of Design Strength Data in Example

Strength of Bolt, S (lb)	$z=(S-s)/\sigma=$ $(S-150{,}000)/3000$	$S(z)$—Probability of S or Less
56,000	−31	0
100,000	−17	0
120,000	−10	0
140,000	− 3.33	0.000483
150,000	0.0	0.5000
155,000	1.67	0.9520

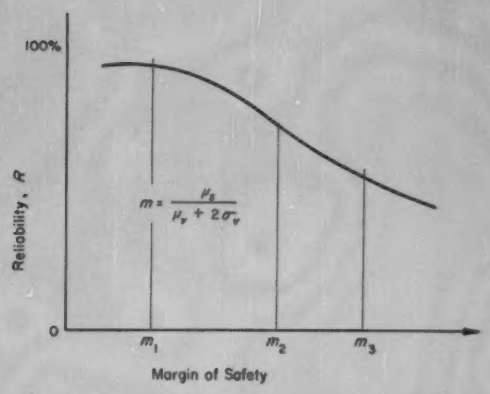


Fig. 11—Effects of margin of safety on reliability. The curve asymptotically approaches unity for large margins.

Risks: The solution to the design reliability depends on four parameters: 1. The mean product strength. 2. The variability of the mean product strength. 3. The mean environmental stress. 4. The dispersion of the mean environmental stress.

The mean stress and variability of the environment can be calculated on the severe side to minimize the associated risk. Separate experiments to determine the actual environment are always desirable, because a design based on maximum information is the most economical.

Fig. 10 shows environments that have a fixed mean value, but have different variances about this mean. Fig. 11 demonstrates the effects on the reliability caused by these changing variances. Notice that although the factor of safety C is constant, the margin of safety and distance from an extreme environment becomes smaller with an increasing variance.

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CLAMPING WITH FLUID POWER

By H. L. STEWART and J. M. MORITZ
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HYDRAULIC and pneumatic devices are extremely popular for clamping or holding work pieces during machining, testing, assembly, and similar operations. There are a number of advantages inherent in fluid power for such applications.

Uniform Holding on Successive Cycles: The same pressure is applied each time the clamp is operated. This is not true for manually operated mechanical devices where operator strength, dexterity, and fatigue are factors. The part is held firmly with the designed pressure without the possibility of distortion or damage due to overclamping.

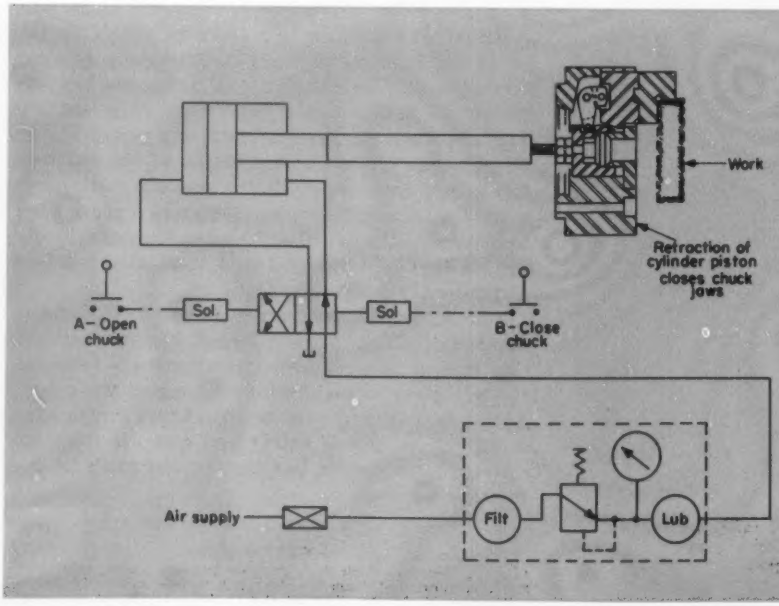
Reserve Movement of Clamping Surfaces: In case of an emergency, reserve movement is automatically supplied. For instance, when holding rough castings during a machining operation, if the surface of the work under the clamping jaws should break or crumble, the reserve movement will restore clamping pressure. In mechanically operated holding devices, a part might be wrenched loose under such conditions. Also, dimensional variations of the work piece are accommodated by the available reserve movement.

Speed of Fluid Power: One of the chief advantages of fluid power is the speed of operation that can be achieved. Speed is, of course, not required in all devices, but a properly designed device can be operated almost instantaneously if desired.

Hydraulic or Pneumatic?

Inevitably the designer must select between hydraulic or pneumatic operation. Each medium has its advantages and disadvantages, but the requirements will usually indicate which is best. Some of the points to be considered in making this selection are:

Space Limitations: There is seldom over 90 psi air available in most plants, while hydraulic sys-



Air-chuck circuit for production lathe. Chucking is done manually with spindle of lathe stopped.

Design of a clamping mechanism is dependent to a large degree on how it is to be operated. This article tells what can be done in clamping with fluid power, how to select between hydraulic and pneumatic operation, and what to consider in circuit design.

tems may operate at up to several thousand psi. This means that a small-bore hydraulic cylinder can impart the same pressure as a large-bore pneumatic cylinder.

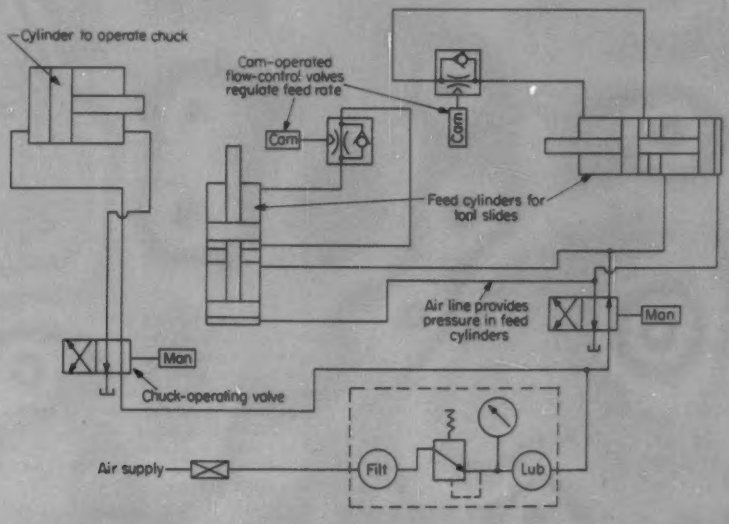
Even though plenty of space is available for an air cylinder, the force required by the application may necessitate a cylinder of such size that it would be impractical. However, if only a 20 or 25-lb force is required and the hydraulic system is designed for 1000 psi operating pressure, it would be impractical to use an extremely small-bore hydraulic cylinder—even if costly pressure valves could reduce the oil pressure sufficiently. In this instance, an inexpensive air-operated cylinder should be used.

Speed Required: Although air and hydraulic systems both give fast action, the rapid expansion of air gives a much quicker action in most instances. When rapid clamping is desired, small-bore, short-stroke air cylinders are recommended. However, there are cases where air is not fast at all. For example, an air cylinder with 12-in. bore and a long stroke demands a great deal of air. If it is operated by a small air compressor, it will not have the rapid movement of a small-bore hydraulic cylinder operated by a proper-size hydraulic power device.

Frequently it is desirable to know how fast a piston of an air cylinder will travel. In a hydraulic system, speed can be calculated quite accurately, but with air there are many variables. Some of the factors that affect the speed attained from a pneumatic cylinder are:

1. Restrictions in the supply lines between the compressor and cylinder.
2. Overloading of central supply system, causing a pressure drop.
3. Abnormal internal friction from lack of proper air-line filtering and lubrication.
4. Packings on rod or piston set too tightly.
5. Poor finish on piston rod or cylinder bore.

Temperature: Air works well for the operation



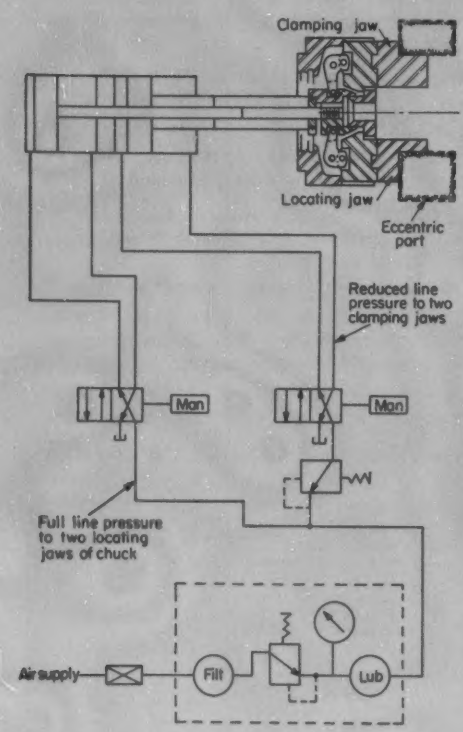
Clamping on semiautomatic lathe is done by pneumatic-cylinder operation of chuck. Feed slides are operated by combination pneumatic and hydraulic circuits

of clamping devices in high-temperature applications. Pneumatic devices are preferred for applications around furnaces, rolling mills, and similar areas of extreme temperatures.

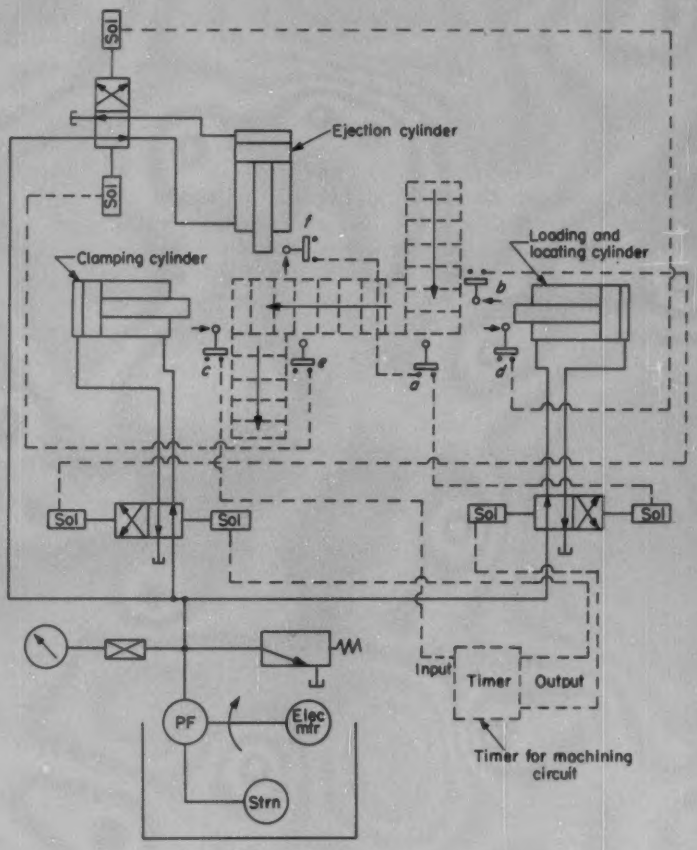
There has been extensive development in hydraulic oils recently in order to make them fire resistant, but there are still some objections to fluids. Among the problems associated with hydraulics in high-temperature applications is that to reduce heat, an aftercooler is often necessary.

Original Cost: In most instances, the cost of a hydraulic system is considerably more than that of a pneumatic system. The end product may not bear the cost of hydraulics even though it may be somewhat more desirable. Part of the reason for the higher cost of hydraulics is that higher pressures are being dealt with, more precise components may be required, and a complete power package is needed. The complete package includes the power source, while in an air system, the air compressor is rarely included since it is part of the plant system.

The Packaged Unit: Where uninterrupted operation is essential, the packaged hydraulic-power device is very desirable. If one power unit should go down for repairs, usually only one machine or one group of machines is affected, whereas if the compressed-air supply fails the entire plant is affected. On very critical installations where hydraulic power is employed, wheel-in standing units



Irregular parts are held in four-jaw chuck with jaws operating in two independent pairs. Jaws are moved in pairs by duplex cylinder that has one piston rod inside the other. Inlet pressures in the two sections of the duplex cylinder need not be equal.



Clamping and work-handling circuit is similar to many automation devices. Incoming work trips switch *a*, and part is pushed into place by loading cylinder. Trip on piston operates switch *b*, and part is located and held in place by opposing clamping cylinder. Piston-rod trip closes switch *c*, starting timer for machining heads. After machining cycle is over, timer operates solenoid valves to retract pistons and release part. Piston-rod trip closes switch *d*, ejecting finished part. Outgoing part closes switch *e* and retracts ejection cylinder. Retraction of ejection-cylinder piston closes switch *f*, wired in series with switch *a*, permitting next cycle to start.

are often used so that little time is consumed in changing from one power unit to another.

▶ Clamping Circuits

Many types of fluid-power circuits are suitable for holding or clamping applications. From an equipment standpoint, applications can be readily divided into two general groups, depending on whether or not the holding device and the clamped part rotate. For rotating devices, the rotative speed greatly influences the selection of some of the equipment. A rotating inlet-exhaust coupling is required, and for high speeds, it may need water cooling.

Rotating applications involving high speeds usually require hydraulic systems. High pressure, or relatively light spindles may also require hydraulic rather than air systems, due to the lighter weight of hydraulic cylinders. Where the holding cycle is long, an accumulator in the circuit permits the pump to operate only when accumulator pressure drops. An accumulator also permits fast opening and closing with a small pump.

In the design of a clamping circuit, the location of the controls in relation to the operator is very important. If the part being located, loaded and clamped manually is of light weight, the operator can be expected to load with one hand. The controls must then be operable with the other hand and located for the operator's convenience. If the work is heavy and demands both hands to load and unload, foot-operated valves are needed.

Nonrotating applications require fewer items of equipment per cylinder. The variations in such circuits are legion, but all are usually relatively simple. The actual holding or clamping device selected is usually determined by the size, shape and nature of the work, and why it is to be clamped. In fixture and machine-tool design, hydraulic or pneumatic chucks, vises, and collets are available in an endless variety and a wide range of sizes.

If at all possible, fluid-power components should be a manufacturer's standard. The mechanism should be designed around the standard component rather than allowing the design to dictate a need for a special component to fit the remaining space. Where large quantities of fluid-power components are required, standard components are not so important, but for small quantity requirements the designer may penalize the product by specifying a nonstandard item. Besides the obvious higher cost of nonstandard components, the matter of repair parts for specials is also a problem.

Tips and Techniques

Temporary Drawing Changes

To make a temporary change without defacing the original drawing, try using a plastic mending tape (for instance, Scotch brand No. 810 permanent mending tape). This tape is translucent and can be written or drawn on with a lead pencil.

Necessary notes or changes are made on the tape, and regular prints can be made. Usually, these prints are stamped "Advance Engineering Information." When the change is made permanent (or deleted due to a redesign), the tape can be easily removed and any correction made right on the original drawing.—JOHN W. HEALEY, *Cuyahoga Falls, Ohio.*

Attaching Title Blocks

When attaching heat-type title blocks to drawings, if a heating iron is not readily available, the job can be done with an electric eraser. With the title block located in the proper place, the eraser, with a soft-rubber tip, is used to trace around the edge of the block. Friction from the tip, rotating in contact with the block, will generate enough heat to melt the adhesive on the label.—JIM BLAIN, *Lockheed Aircraft Corp., Missile Systems Div., Newhall, Calif.*

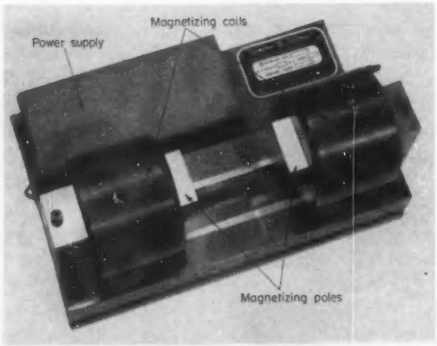
Tube-Bend Specifications

Realistic dimensioning or specification of allowable tube-bend distortion can be a problem, due to the difficulty of inspecting or measuring the bend distortion in the shop. A simple approach is to specify the minimum-diameter of inscribed circle. This dimension can be easily checked in the shop by dropping a ball of appropriate size into the tube. If the ball is stopped at the bend, the distortion is greater than the specification permits.—CLINT MCLAUGHLIN, *Rockaway, N. Y.*

Keeping Drawings Clean

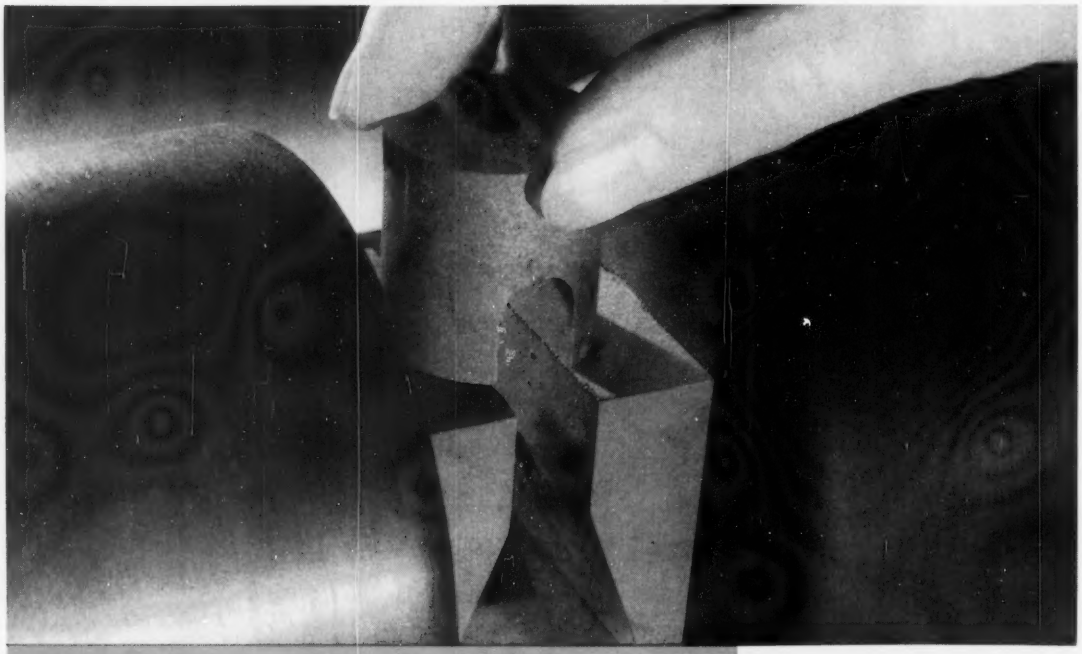
Sliding plastic tools over a drawing, and handling them, results in an electrostatic charge on the tools that will attract and hold dirt particles. Dust from pencils and from the atmosphere accumulates on the tools and results in dirty tracings. This same dust problem exists with phonograph records. Sprays are available in most record shops that will eliminate build-up of the charge. The sprays are sold in pressure cans, and one application provides a coating that will last for three or four months.—GEORGE WILLIAMS, *C-H Tool Co., New York.*

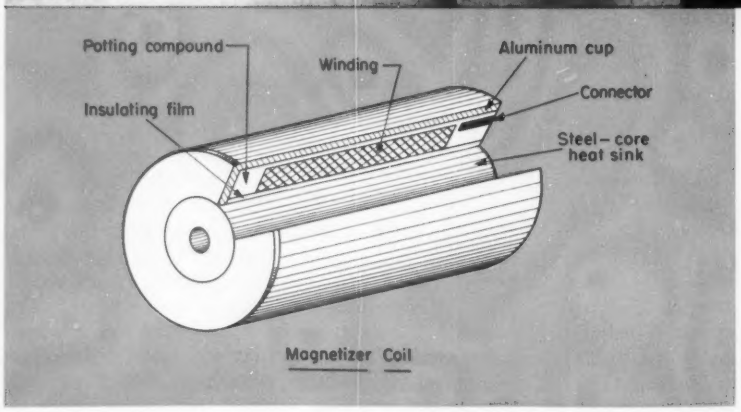
Mounting Sockets and Coil Cores



A new line of magnetizers has been developed that is considerably reduced in size and simplified in design. As reported by George D. Barcus Jr., magnet product engineer, Metallurgical Products Dept., General Electric Co., novel construction techniques are employed for cooling magnetizing coils and power-supply diode rectifiers.

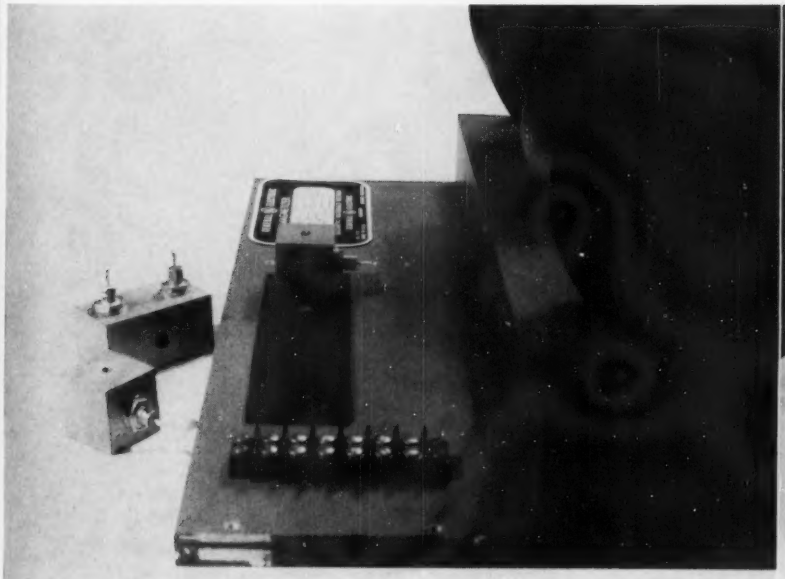
Effective cooling of units, which are designed to magnetize permanent magnets, keeps surface temperatures well below operator discomfort levels.

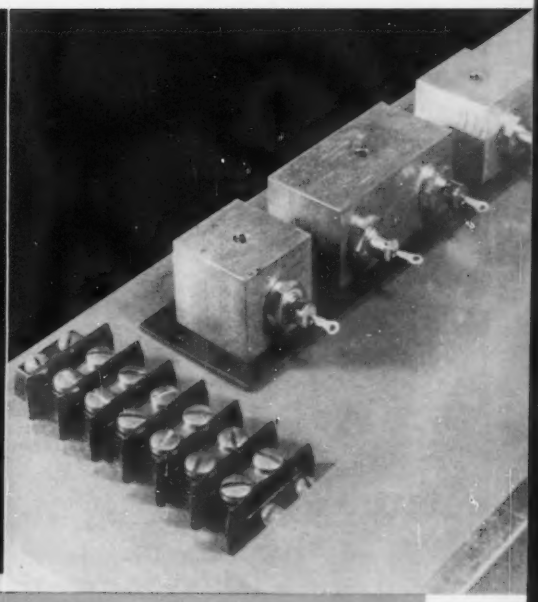




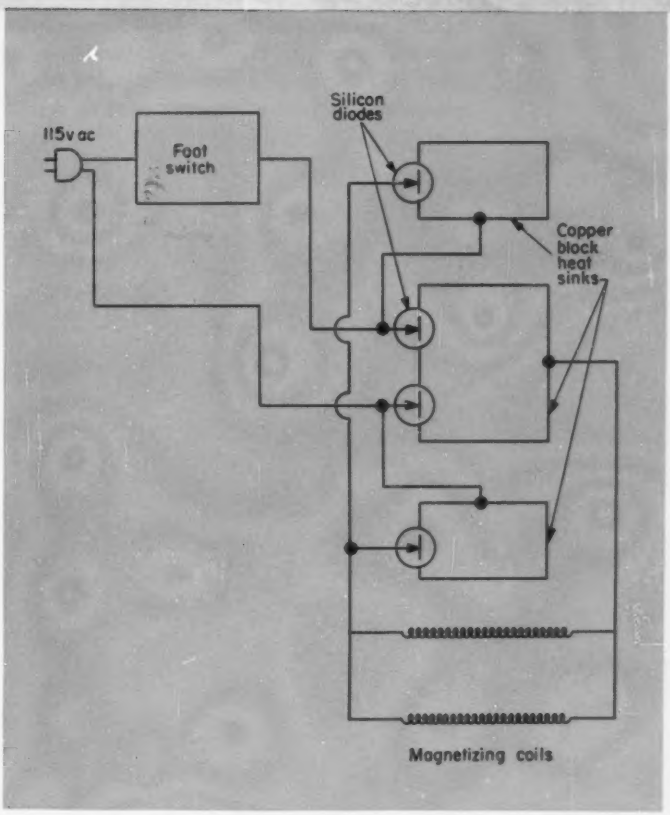
Magnetizer coil heat is easily dissipated through a thin Mylar film that insulates the coil winding from the steel core of the magnetizer. The steel core and coil assembly is mounted in an anodized, spun-aluminum cup and potted with an epoxy compound.

Double as Heat Sinks





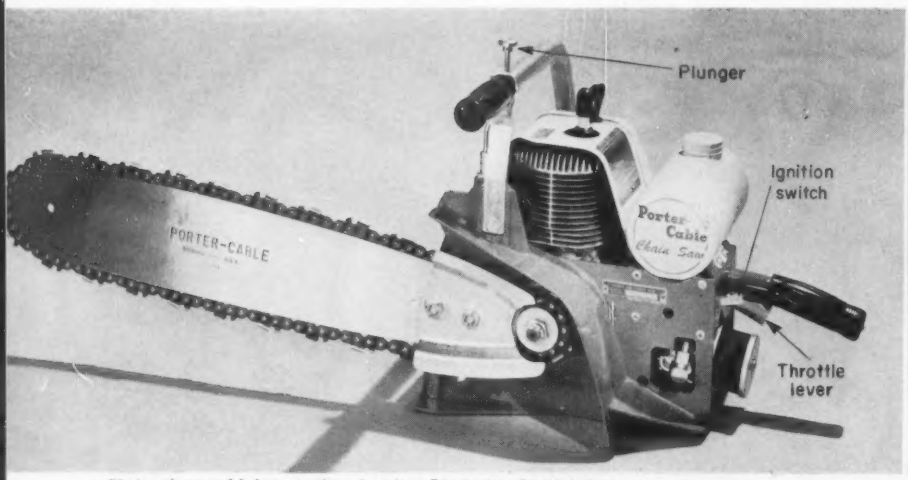
Copper-block mounting sockets provide adequate cooling of silicon diodes in rectifier power supply. Threaded-base diodes screw into the copper blocks. The end blocks are 1-in. cubes and the center one is double that size in the small magnetizer size. Each copper block is mounted on a Textolite peg and sheet that electrically insulates the block from the aluminum base plate. The sheet of insulation is cemented to the base plate.

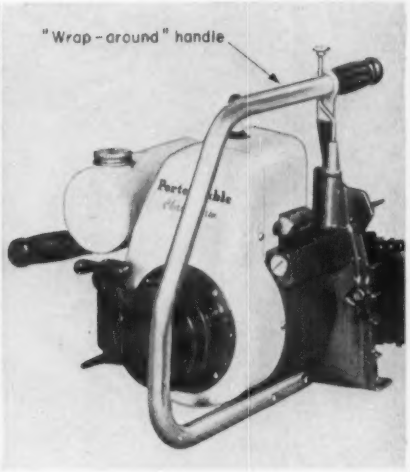


Rectifier power supply wiring diagram for magnetizer shows how copper blocks double as heat sinks and serve as good circuit connectors. Since the silicon diodes are screwed into the mounting blocks, good contact is assured.

The smallest power supply in this magnetizer line can provide 2 amp dc at 100 v; the largest, 35 amp dc at 200 v.

"Bicycle" Handle Grips Mounted at

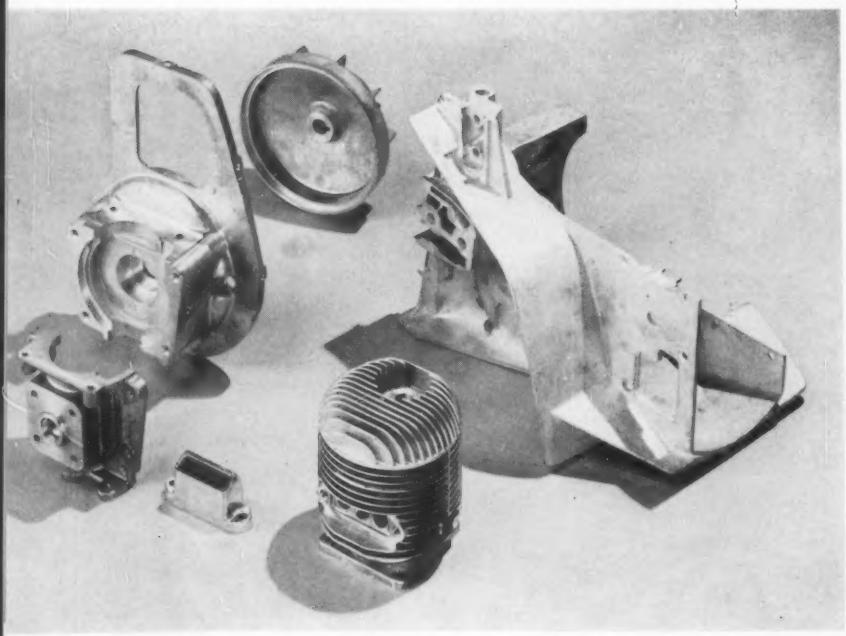




Photos above and below, courtesy American Die Casting Institute Inc.

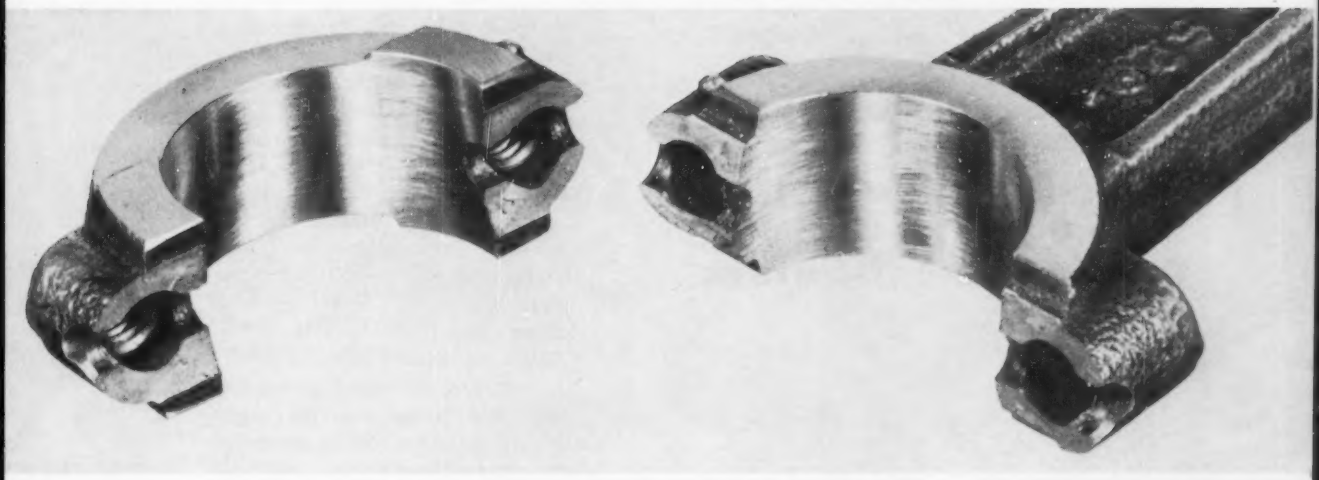
Front and rear handles on the new Porter-Cable model 530 chain saw are designed to give operator maximum control of tool on any type of cutting. The handles are made of tubular steel covered with bicycle type handle grips. The "wrap-around" handle on the front also serves as a protective guard for the 3.5-hp engine and as part of the saw base to permit setting the saw on the ground.

The engine plunger control is built into the front handle, and the ignition switch and throttle control are mounted within finger reach of the rear handle.

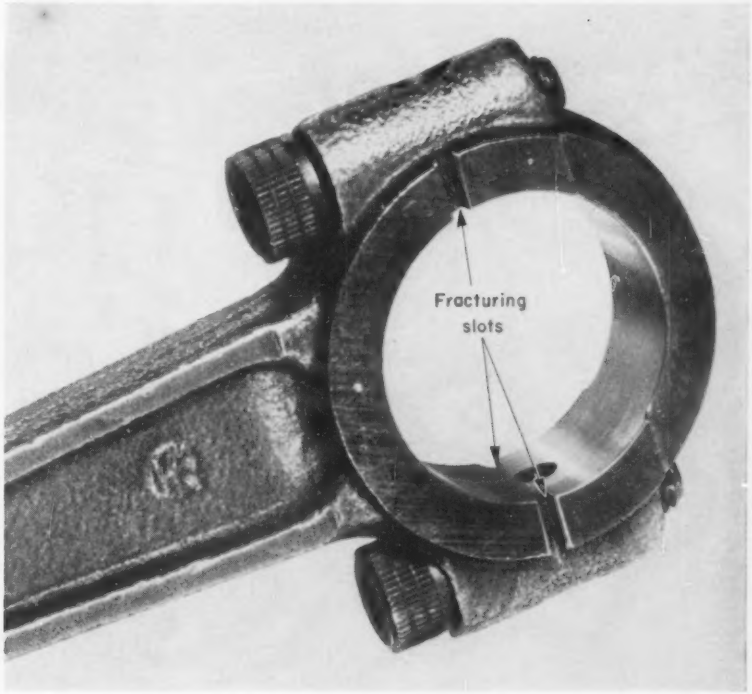


Aluminum die castings are used for the intricate frame and engine parts to make a lightweight unit. Without guide bar and chain, the saw weighs only 24 lb. The engine is designed for either a float or diaphragm type carburetor and employes Neoprene seals on shaft and main bearings.

Right Angles Aid Tool Maneuverability

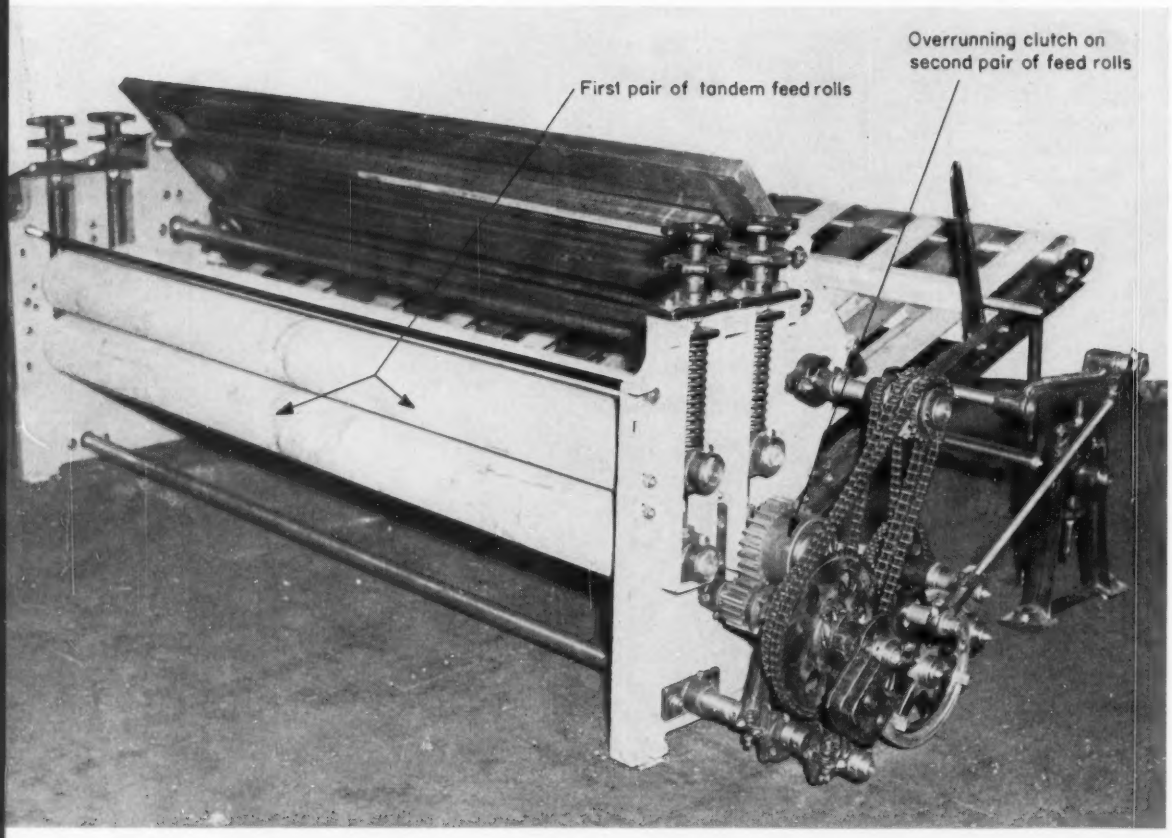


"Fractured" construction of a connecting-rod cap results in perfect alignment of cap and rod, giving less wear and longer bearing life. The rod and cap are cast in one piece. Rough machining is done, then the cap is separated from the rod by "fracturing" or breaking. First a slot is cut half way through the rod from each side at the point of separation (right). Then rod is given a sharp blow which fractures the metal remaining (above). The two pieces are reassembled and the machining is finished. This produces a joint with many rough, uneven edges that will match perfectly only with the piece from which it is broken.



Tandem Rollers Serve as Cutting Mechanism

Cutting mechanism in an automatic batt cutting-off and folding machine made by the James Hunter Machine Co. consists of two pairs of heavy steel compression rolls running in 1:1 tandem. When a predetermined length of batting material passes through the feed rolls, a Formsprag overrunning clutch on one of the rolls is tripped, causing one of the rolls to run three times faster than the other. This rapid change in speed results in a cutting or tearing action that separates the batt material. Length of the cut-off pieces is controlled by a timing gear arrangement with a movable stud that trips the overrunning clutch at the proper time.



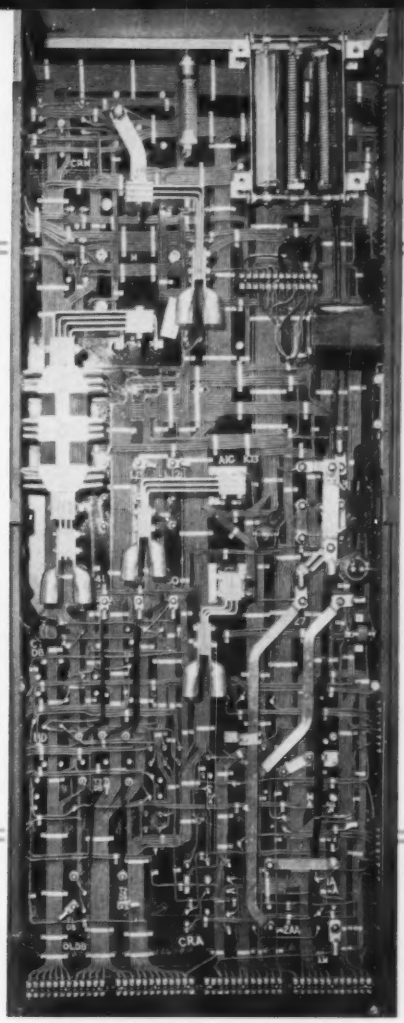


Fig. 1—Flat wiring. The wires are easy to trace and appearance is excellent. The wiring cannot easily be changed to make design modifications, and installation time is relatively long.

Electrical
Wiring Methods

An Up-to-Date Report on

Types of Wiring
Electrical Characteristics
Physical Characteristics
Application Techniques

By J. W. KELLER
Industry Control Dept.
General Electric Co.
Roanoke, Va.

THERE is no one panacea for the varied wiring problems encountered in design, but there are short-cuts to efficient and effective wiring methods. These short-cuts have been made possible in large part by recent developments and innovations throughout the electrical industry.

The sundry approaches to wiring methods are necessarily determined by the application and peculiarities of the equipment being produced. Machines or equipment produced on a highly repetitive basis, such as automobiles or TV sets, can be designed for wiring techniques that would not be suitable for tailor-made equipment. So-called electronic circuits often pose wiring problems not encountered in electrical systems in certain industrial equipment. And, by the same token, accepted wiring techniques on switchboards and control panels bear little resemblance to the methods employed in automotive or aeronautical circuits.

It becomes apparent that the advantage of one wiring method for a given application may be a definite disadvantage for all other types of applications. Since wiring requirements vary to such extremes, it is interesting to note the characteristics and qualities of some of the methods that have already gained popular acceptance.

The methods most commonly used today include flat wiring, cable wiring, harness wiring, printed circuits, and channel wiring.

Flat wiring is a technique in which all wires are fastened to each other in layers next to a base, Fig. 1. Because of this feature, the wires are easily traceable, and an excellent appearance results. Ordinarily, for any given job, it is desirable to have the complete flat-wiring installation made by the same individual. Once the wiring is installed, it does not readily lend itself to modifications or design changes. Another disadvantage of the flat-wiring technique is that it is extremely difficult to maintain consistency in the appearance of two or more similar pieces of equipment.

Cable wiring is perhaps the most common type

of wiring used in control boards, Fig. 2. It is basically similar to flat wiring except that several wires are bunched together in a neat cable and tied at regular intervals with stout cord. Because of this, any changes or replacements are quite time-consuming and costly. This method is especially applicable on nonrepetitive jobs and is used most advantageously where five or fewer pieces of equipment are involved.

Harness wiring, Fig. 3, is typically used where the number of similar jobs is more than five. This technique consists of prefabricating wire bundles that are later mounted in equipment and connected. The appearance and characteristics of harness wiring are similar to those found in cable wiring. The primary difference lies in the method of application. Harness wiring is a well-proven method and is appropriately applied on mass-production equipment such as automobiles, airplanes, and almost all other repetitive circuits. It is also applied in control panels to great advantage.

Printed wiring is a method that has gained rapid acceptance in the electronics industry. The nature of its construction has confined its application to circuits of comparatively low currents. The wiring technique is not generally employed in circuits other than electronic types.

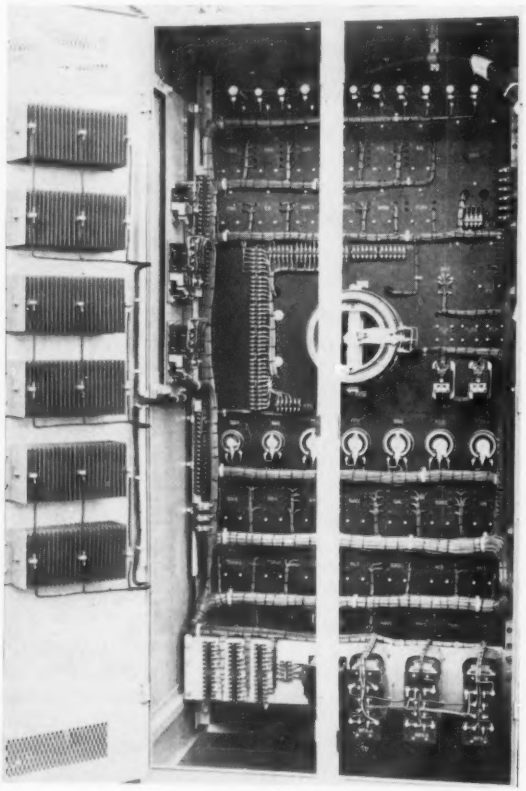


Fig. 2—Cable wiring. Neat bundles of wire are tied together at regular intervals with cord. Changes are costly and difficult.

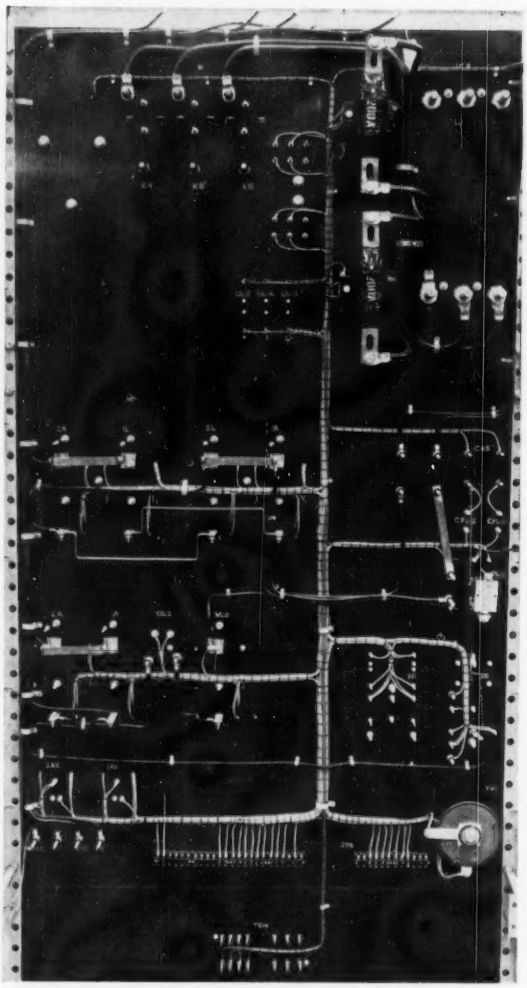


Fig. 3—Harness wiring. In this technique wiring is completely prefabricated before it is mounted in equipment. It is particularly applicable to mass-produced machines, such as automobiles.

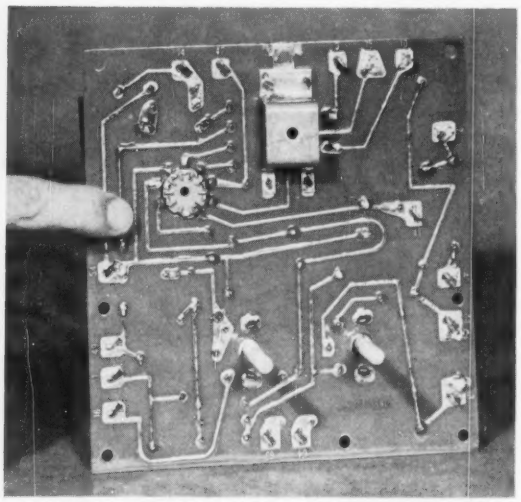


Fig. 4—Printed wiring used on a printed-circuit board on an adjustable-speed drive control.

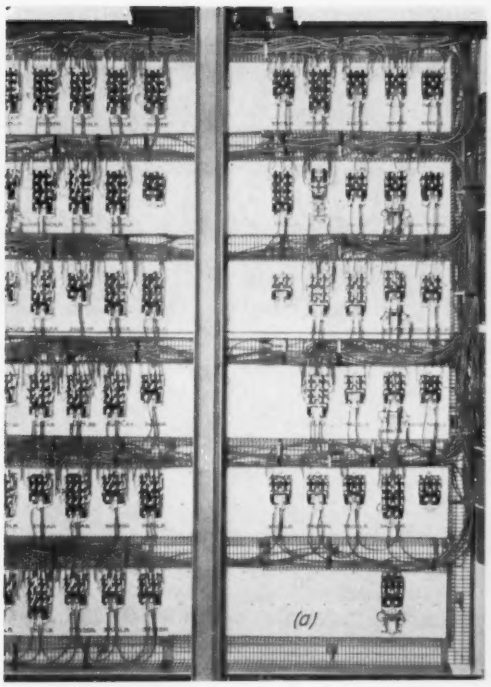


Fig. 5—Above—Control board using plastic-covered wire mesh for wiring channels, *a*. Plastic-coated steel covers are fastened over the channels, *b*, after all wiring is completed.

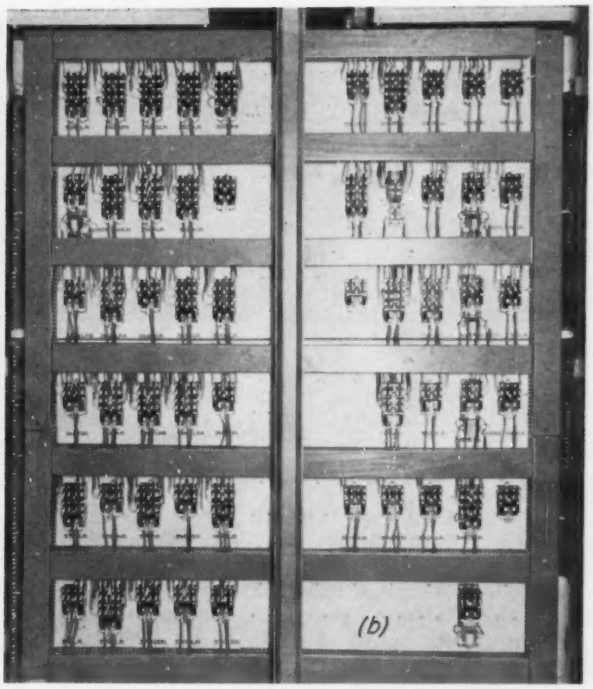


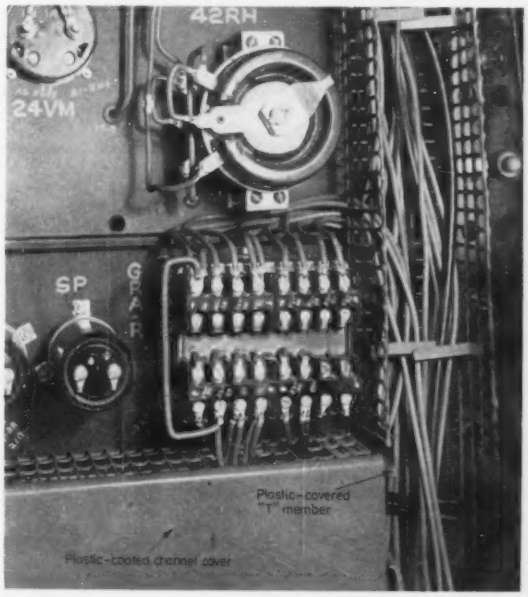
Fig. 6—Below—Close-up view of one channel-wiring method showing the plastic-covered wire mesh channel, plastic-coated steel covers, and plastic-covered "T" connectors. Wire mesh has 1 by ½-in. openings allowing for good heat dissipation and ample wiring space.

Channel or trough wiring is a comparatively new method of wiring. The basic form consists of a fabricated channel with openings in the sides and sometimes in the bottom. Wires are led into the channel through these openings and then run along the channel, leaving it only at the proper point of termination. Because of its flexibility and sturdy construction, channel wiring is being applied more and more in switchboard and control-panel construction.

All channel wiring utilizes the same basic principle. The major difference in each case is the material used for the channel itself. The following are some of the more popular materials used: fiber, glass-filled polyester, phenolic, and steel.

One wiring-channel design that has recently been developed at General Electric is constructed of Plastisol-coated steel mesh, Figs. 5 and 6. The Plastisol coating, which is similar to Flamenol now used as a primary insulator for most wire and cable, makes the channel an insulated member. Joints between the vertical and horizontal channels are made with the aid of smooth Plastisol-coated "T" connectors, Fig. 6. After the wires are installed, the Plastisol-coated steel covers are placed over the open front of the channel and held in place by wing nuts.

Channel type wiring is especially adaptable to control circuits in that the wiring layout is actually engineered into the job. This means that the layout of the wire is not left up to individual wiremen, and when control panels are duplicated, they will appear identical regardless of who does the wiring or when it is done. The job can be started by one man and completed by another since wires are run individually rather than in bundles. Wires are easily traceable during installation.



All of the wiring methods and materials discussed here have practical applications for which they are best suited. Design and cost analysis will show which method best satisfies application requirements.

Designing with Teflon

Part 3—Thermal, Chemical,

A SUMMARY of major properties of Teflon tetrafluoroethylene plastics is presented in this article and the previous article in this series (Sept. 19 issue, Page 162). Properties such as strength, stiffness, creep, cold flow, and stress relaxation have been covered in Part 2. This article describes:

1. Temperature effects.
2. Effect of chemicals.
3. Fatigue and impact.
4. Hardness, and friction and abrasion resistance.

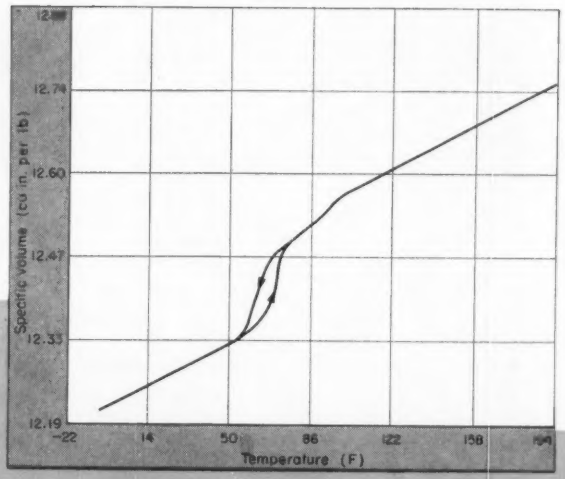
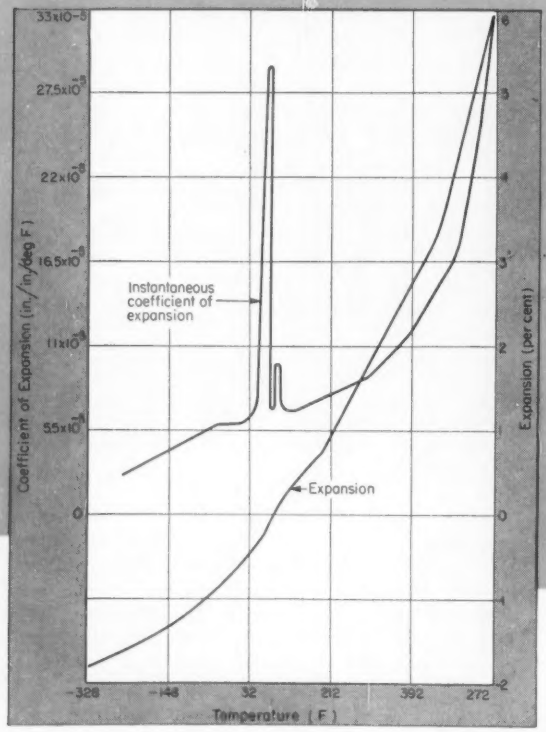
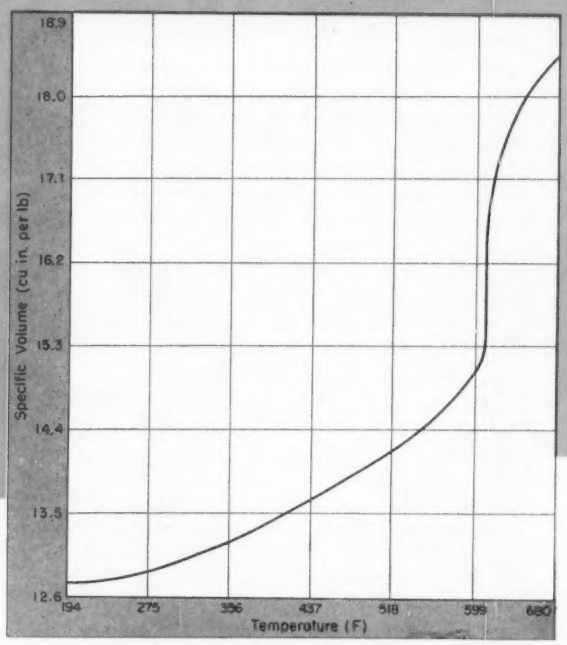


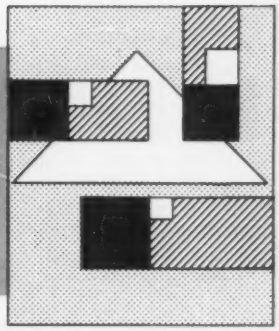
Fig. 27—Specific volume versus temperature for Teflon 1.[2]

Fig. 26—Linear thermal expansion and instantaneous coefficient of linear expansion of Teflon tetrafluoroethylene plastic (54 per cent crystallinity, annealed)[1]





Wear and Electrical Properties



5. Electrical properties,
6. Weathering resistance, permeability, and vibration damping.

How these properties can be adjusted in manufacturing has already been described in Part 1. The next article (Part 4) will cover specifications for manufacturing components in Teflon.

This series is based upon information supplied by E. I. du Pont de Nemours & Co. Inc.

▶ Effect of Temperature

Thermal Expansion: Teflon tetrafluoroethylene resins have an average linear coefficient of expansion[1] as outlined in Table 17. Fig. 26 shows linear thermal expansion and coefficients of linear thermal expansion of annealed parts fabricated of Teflon.

Fig. 27 shows change in specific volume when heated from −22 to 680 F. Note the radical change in volume (1.0 to 1.8 per cent) at the transition zone from 65 to 77 F in Fig. 27*a*. This change in volume is not instantaneous with change in temperature, as illustrated by the two lines representing heating and cooling.

This phenomenon is most important in machined parts. A machined part which has been

[1]References are tabulated at end of article.

Fig. 28—Compressive yield strength (0.2 per cent offset) as a function of temperature. Crystallinity is 56 per cent.[3]

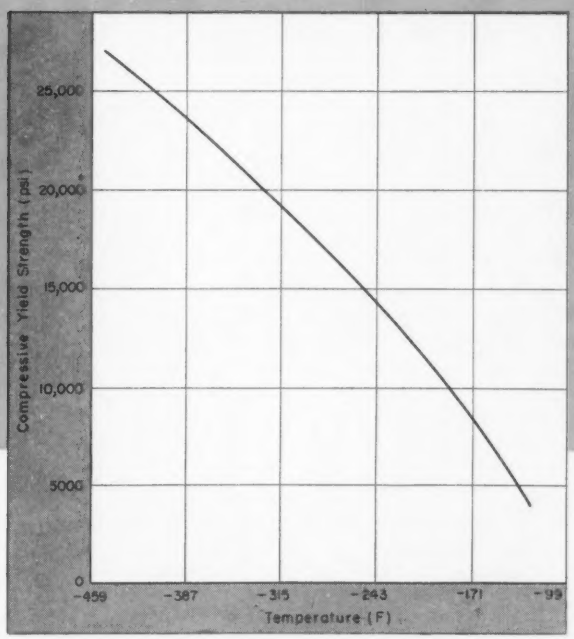
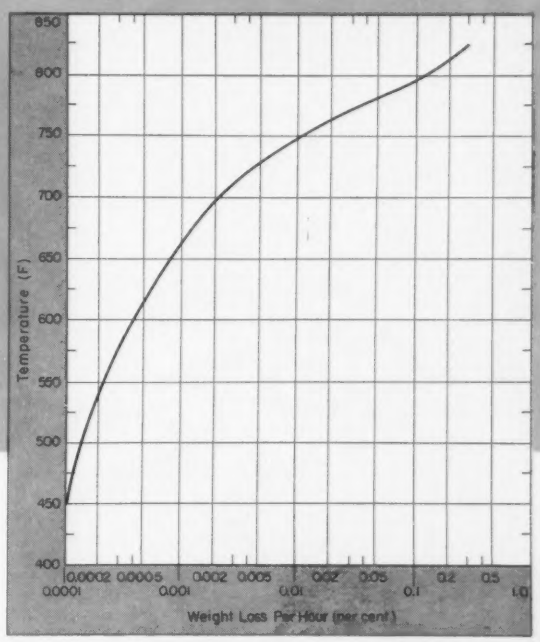


Fig. 29 — Decomposition rate versus temperature for Teflon 1.



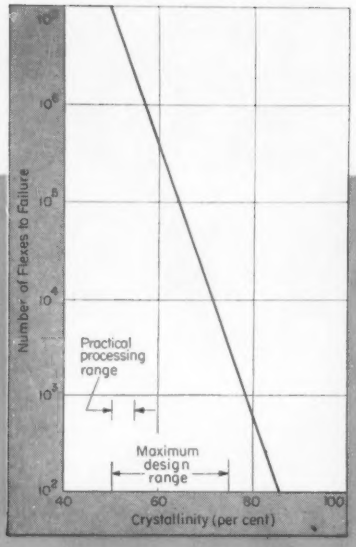


Fig. 30 — Left — Number of flexes to failure versus crystallinity.

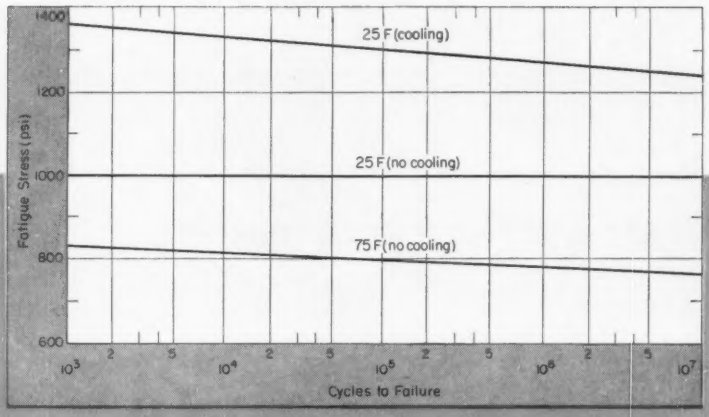


Fig. 31 — Above — *S-N* diagram for Teflon 1. Stresses are completely reversed tensile-compressive stresses.

Table 17—Linear Coefficients of Expansion of Teflon

Temperature Range (F)	Linear Coefficient of Expansion (10^{-5} in./in./deg F)
+77 to −310	4.77
+77 to −238	5.33
+77 to −148	6.21
+77 to −58	7.50
77 to 32	11.10
77 to 122	6.90
77 to 212	6.90
77 to 302	7.50
77 to 392	8.40
77 to 482	9.70
77 to 572	12.10

Table 18—Izod Impact Strength

Temperature (F)	Izod Impact Strength (ft-lb per in.)
−70	2
73	3
170	6

ASTM D 256-47T

Table 19—Hardness of Teflon and Reinforced Teflon

Material	Volume of Additive (per cent)	Shore Durometer Hardness (D scale)
Teflon tetrafluorethylene resin	None	55-65
Teflon tetrafluorethylene resin reinforced with:		
Coke flour	12.5	68
	25.0	67
	50.0	71
Asbestos	12.5	63
	25.0	68
	33.3	70
Glass fiber	12.5	66
	25.0	67
	33.3	73
	50.0	70
Copper	8.0	59
	15.5	62

All at 77 F.

produced within tolerances on either side of this transition zone will obviously change dimensions if permitted to go through the zone. Thus, final operating temperature of the part must be accurately assessed on precision parts. Parts must be measured on a production basis to allow for this volume change if the transition zone is traversed either in manufacturing or operation of the part.

Thermal Conductivity and Specific Heat: Thermal conductivity of Teflon plastics is 1.7 Btu/hr/sq ft/deg F/in. Specific heat is 0.25 Btu/lb/deg F.

Low-Temperature Properties: Fabricated parts of tetrafluoroethylene resin have excellent properties at low temperatures. High strength, plus toughness, and self-lubrication are provided at these extremely low temperatures. Compressive yield strength is given for temperatures down to −450 F in Fig. 28.

Elastic Memory: When a part fabricated from Teflon creeps or deforms over a period of time under stress, it will recover its original shape when it is raised to sintering temperature. Relaxation will occur at temperatures lower than the sintering temperature and, at any given temperature, relaxation is substantially complete in 15 minutes or less. However, extent of relaxation increases with increased temperature.

As an example, a filament fabricated of tetrafluoroethylene 4 in. long, when stretched to a length of 12 in. and heated at 212 F, relaxes to approximately 11 in. within 15 minutes and then remains substantially the same length. A similar piece heated to 392 F relaxes to a length of 10 in. The first piece, after treatment at 212 F and heating to 392 F, undergoes further relaxation

until it is 10 in. long. When these pieces are heated to 662 F, they return to their original length of 4 in.

Decomposition Rate at Elevated Temperatures: Parts fabricated of Teflon plastic are nonflammable, and decomposition due to heat is insignificant below 750 F, Fig. 29. Presence of oxygen or air neither accelerates nor inhibits decomposition rate due to heat. Caution is needed when tetrafluoroethylene resins are exposed to elevated temperatures, since a health hazard may be created.

Tetrafluoroethylene resins have the highest temperature resistance of any thermoplastic material and are ideally suited for many applications where temperatures to 500 F are encountered. For example, soldered wire connections insulated with Teflon plastic in close quarters are feasible because this insulation is undamaged by heat from the soldering iron. Other electrical applications where high heat is a factor, such as jet and rocket engines, have proved to be entirely feasible.

Effect of Chemicals

Probably the most outstanding property of tetrafluoroethylene plastics is superior resistance to chemical attack. They are unattacked by all highly corrosive chemicals and powerful solvents except the alkali metals at high temperatures and pressures, and fluorine. Certain fluorinated chemicals may attack Teflon. This chemical resistance has solved some of the most difficult corrosion problems in industry. Packings for pumps and valves, diaphragms in industrial control valves, and gaskets in chemical pipe lines are some of the uses for this versatile "corrosion-proof" material.

Piping and equipment lined with these resins are not only protected from chemical attack, but products in contact with the Teflon are produced free from contamination due to corrosion. These resins, with their self-lubricating properties, are used in fabricating liners for plug-cocks for chemical service. They prevent "freezing" of the plug

Table 20—Effect of Rubbing Speed on Coefficient of Friction

Apparatus	Approximate Rubbing Speed (ft/min)	Coefficient of Friction
Sliding hemisphere	0.02 to 2	0.04
Sliding hemisphere	0.02	0.04-0.1
Flat ring	Hand turning	0.016
Crossed cylinders	8	0.09
	367	0.21
Rotating cylinder	2	0.05-0.08

Table 21—Dynamic Coefficient of Friction of Reinforced Compositions

Additive	Additive Weight (per cent)	Coefficient
Surface speed, 1 ft/min; loading, 1500 psi		
Teflon tetrafluorethylene resin reinforced with:		
Molybdenum disulfide	30	0.026
Graphite	30	0.031
Coke flour	10	0.017
Coke flour	20	0.023
Coke flour	30	0.027
Surface speed, 20 ft/min; loading, 120 psi		
Teflon tetrafluorethylene resin reinforced with:		
Glass fiber	25	0.230
Graphite	40	0.190
Bronze	40	0.240
Copper	85	0.330

Fig. 32 — Below — Hardness versus crystallinity.

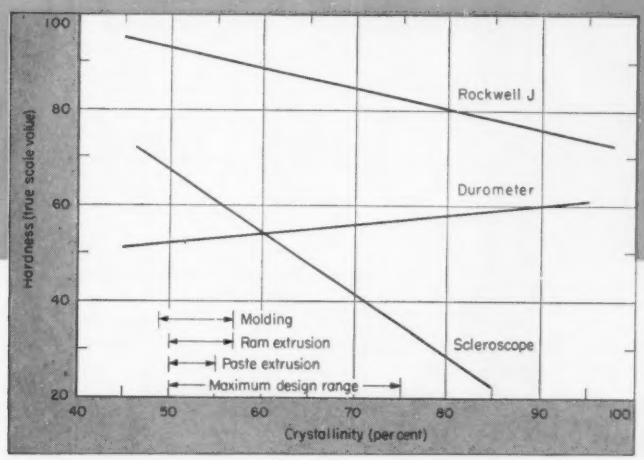
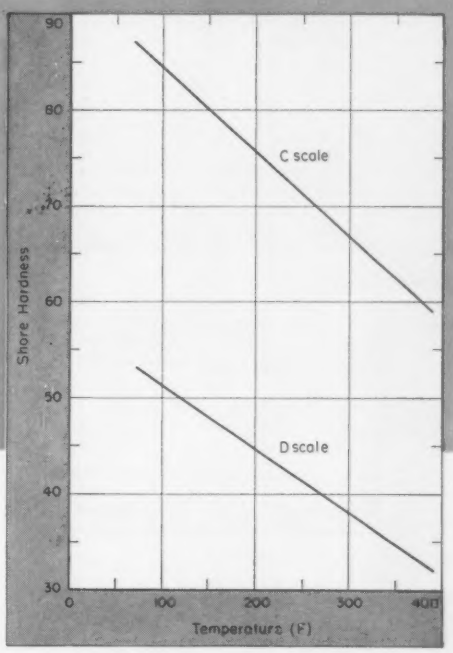


Fig. 33—Right—Effect of temperature on Shore hardness.



and eliminate periodic lubrication. Pliable texture and chemical resistance of these moldings make them virtually a standard gasket material for glass-lined piping and equipment. Molded tetrafluoroethylene plastic has zero moisture absorption.

Molded parts of Teflon plastics reinforced with other materials, such as glass fiber, have increased strength and wear properties. Reduction in resistance to most chemicals is insignificant; however, this does vary with chemical resistance of the reinforcing material used. The glass fiber and Teflon combination is used successfully for impellers in small rotary pumps designed to handle highly corrosive solutions at elevated temperatures. Bellows-type expansion joints are used in corrosion-resistant piping systems (glass, glass-lined, porcelain) to give flexibility due to thermal changes.

For threaded stainless-steel pipe lines in corrosive service, a dispersion of tetrafluoroethylene not only provides a leakproof joint, but prevents galling the threads and assures easy disassembly.

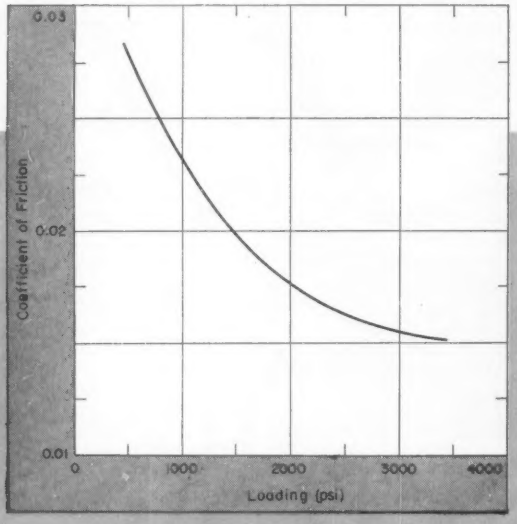
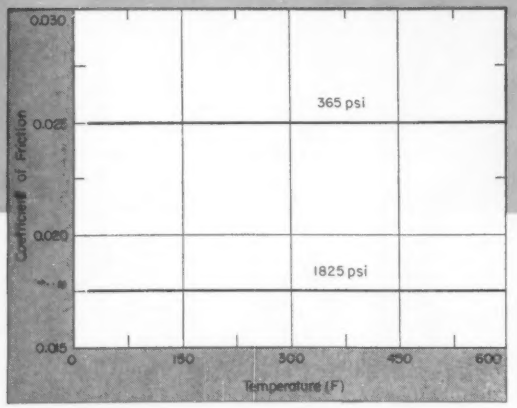


Fig. 34—Above—Coefficient of friction between Teflon 1 and micropolished steel. Loads were applied normal to mating surfaces at 73 F.

Fig. 35—Below—Coefficient of friction between Teflon 1 and micropolished steel compared with temperautre.



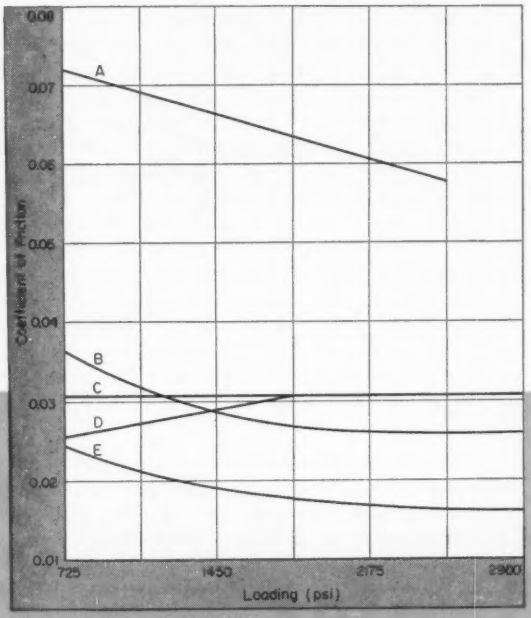
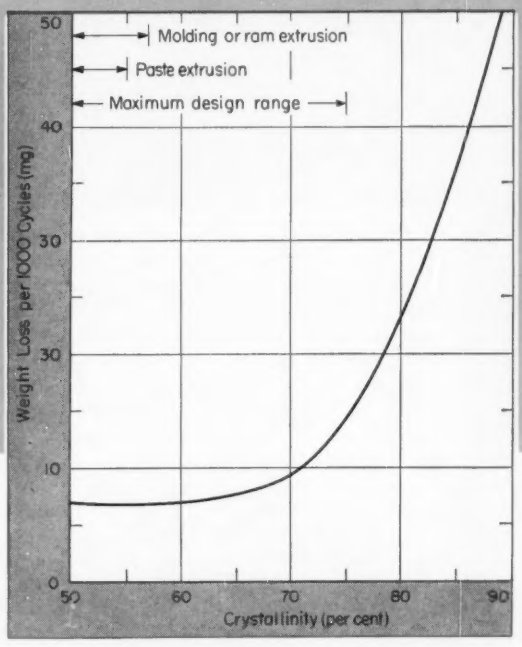


Fig. 36—Above—Coefficient of friction between reinforced or filled Teflon compositions and micropolished steel as compared to loading: *A*, 50 per cent copper filler; *B*, 30 per cent molybdenum disulfide; *C*, 30 per cent graphite; *D*, 30 per cent asbestos; *E*, no reinforcement or filler.

Fig. 37—Below—Taber abrasion weight loss (1000-gm load) versus crystallinity.



Due to the basic methods of molding granular Teflon by compaction of a powder followed by sintering, the particle size and the molding procedure have an important influence on the void content of the resultant products. This is naturally of fundamental importance when the Teflon is to be used as a chemical barrier to prevent corrosion, as with pipe and equipment linings.

A fact not as readily recognized is that high void content can lead to increased sensitivity to degradation by mechanical action. Penetration of the voids by the process materials, followed by expansion and contraction due to changing temperature and pressure conditions can result in degradation. At times this has every appearance of chemical attack, although exposure tests and measurements of weight and physical property changes have established that this is not the case. Effects are actually due to mechanical action. This sort of degradation can often be corrected by using finer molding powders and molding conditions to minimize void content.

Fatigue and Impact

Fatigue: Molded tetrafluoroethylene plastics have fatigue endurance properties which enable them to be used for diaphragms in valves and other equipment where corrosive conditions and temperature prohibit the use of other engineering materials. Fatigue endurance increases drastically with lower crystallinity, Fig. 30. Another example of the use of this favorable property is in bellows for expansion joints in pipe lines handling corrosive liquids or gases at elevated temperatures.

Fig. 31 shows variation of fatigue life of Teflon 1 at various stress levels and thermal conditions.

Impact: Impact resistance of parts molded of tetrafluoroethylene resins at subzero temperatures is outstanding among plastics, Table 18. It is the only plastic material reported tough at −450 F. Thus, where subzero temperatures are encountered, this material may offer an easy solution to an otherwise complex problem.

In designing for impact loads, it is desirable to eliminate, or at least reduce to a minimum, areas of stress concentration. Inside and outside corners should be rounded, and fillets used where thickness of a section changes. Thus, when an impact load is encountered, stresses are not highly concentrated. Excessive stress concentration will produce a surface crack, and failure will occur under repeated impact.

Bearings of molded tetrafluoroethylene and other mechanical components illustrate the excellent fatigue and impact properties of this engineering material.

Table 22—Effect of Lubrication on Coefficient of Friction of Reinforced Teflon

Lubricant	Teflon-Asbestos (3:1 by weight)	Teflon-Copper (1:1 by weight)
No lubrication	0.15	0.16
Water	....	0.09
Oil	0.04	0.04

From Reference 4.

Hardness, Friction, and Abrasion

Hardness: Molded Teflon plastics have a hardness which, together with their chemical resistance and frictional properties, makes them an excellent bearing material. Figs. 32 and 33 show variation of hardness with crystallinity and temperature, respectively. A comparison of hardness is given in Table 19 between Teflon resins and various reinforced compositions which are frequently used in industrial applications.

Fig. 38—Dielectric strength of skived tape versus thickness (short-time test, 1-in. electrode, oil immersion, 1/16-in. round on electrode).

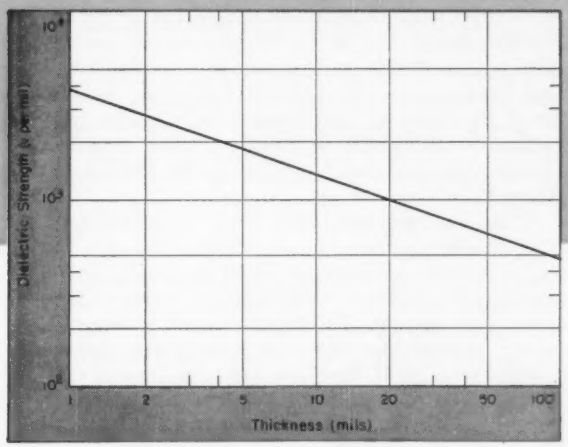
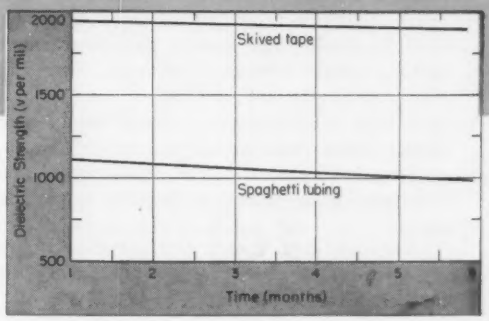


Fig. 39—Dielectric strength versus time (after heat aging at 482 F).



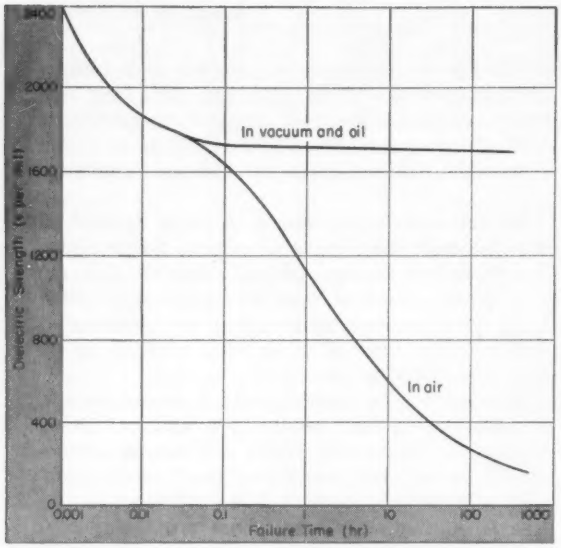


Fig. 40—Dielectric strength of Teflon 1 after aging.

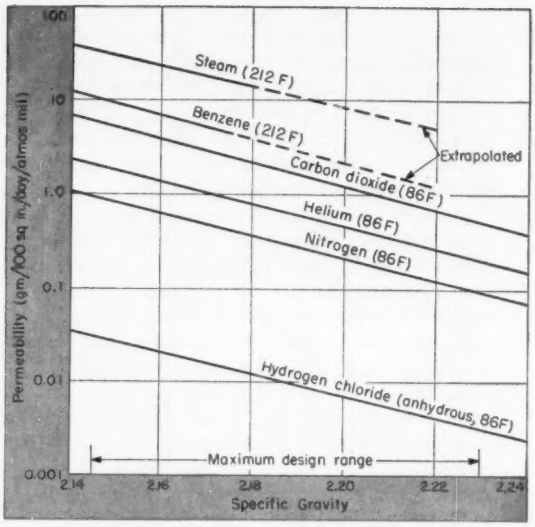


Fig. 41—Permeability versus specific gravity at 77 F.

Table 23—Wear of Dry Reinforced Teflon Bearings

Material	Average Wear per Million Revolutions (in.)
Teflon tetrafluorethylene resin reinforced with:	
20% Glass fiber and 20% molybdenum disulfide	0.00017
25% Glass fiber	0.0005
25% Mica	0.0006
40% Aluminum	Too worn to measure
40% Bronze	0.00005
85% Copper	0.001
40% Graphite	0.00077

½ in. diam hollow shaft of hardened drill rod. Temperature maintained at 100 F by water cooling. Speed, 156 rpm; bearing pressure, 120 psi under normal room conditions.

Friction: Tetrafluoroethylene resins are used in many journal and plane surface bearing applications. In food processing plants, textile mills, and bakeries, bearings of molded Teflon have eliminated product contamination from bearings requiring frequent lubrication. Other mechanical applications that require good frictional properties and superior chemical resistance are moving surfaces on mechanical seals in pumps, and valve-stem packing.

Figs. 34 through 36 and Tables 20 through 22 show coefficient of friction data for both Teflon tetrafluoroethylene resins and reinforced compositions under various conditions. Note in Fig. 36 that the coefficient of friction for reinforced compositions is only slightly higher than for the basic resin, which has the lowest coefficient of friction of any solid material. For this reason, these compositions make excellent bearing materials.

Abrasion and Wear: Parts fabricated of tetrafluoroethylene plastics have good wear properties and, for relatively light loads at low rubbing velocities, make excellent bearing surfaces. However, under relatively heavy loads and high rubbing velocities, reinforced compositions of tetrafluoroethylene resins are recommended. Wear properties are improved by reinforcing with materials such as glass fibers, mica, bronze, copper, graphite, and others. These materials are also less expensive than Teflon and substantially reduce the cost of the finished part. Any inorganic reinforcing agent capable of withstanding the sintering temperature (640 F) can be used. The two most commonly used are glass fiber and graphite.

Shown in Fig. 37 is variation of abrasion (Taber, ASTM D 1044) with crystallinity. Table 23 shows comparative wear rates of several reinforced compositions of tetrafluoroethylene plastic when used as a dry bearing.

Electrical Properties

Parts fabricated of tetrafluoroethylene plastics have an excellent combination of electrical, thermal, and mechanical properties for use in electrical insulation at high frequencies and high temperatures. Properties of interest to the electrical designer are presented in Figs. 38 through 40 and Table 24.

These electrical properties are truly outstanding. The dissipation factor is less than 0.0003 over the entire spectrum measured of 60 cycles to 10,000 megacycles. Volume resistivity is greater than 10^{13} ohm-cm, even after prolonged soaking in water. Teflon has no water absorption. Surface resistivity is quite high and remains greater than 10^{17} ohms per square at 100 per cent relative humidity.

Table 24—Electrical Properties

Dielectric strength	Fig. 38-40
Dielectric constant,* 60 to 10^{10} cycles	2.0-2.5
Surface arc resistance	Excellent; does not track; no carbon formation
Volume resistivity* (ohm-cm)	10^{13}
Surface resistivity at 100% relative humidity* (ohms per square)	10^{17}
Dissipation factor, 60 to 10^{10} cycles	0.0003

*No measurable changes occur in these values when exposed to 482 F temperatures (250 C) for 6 months.

Electrical components of Teflon also have good arc resistance. On prolonged exposure to an initially intermittent arc for at least 200 seconds, some decomposition to gaseous products may occur; however, no carbonized path is formed regardless of temperature.

Short-time dielectric strength values are high. These range from 500 to 4000 v per mil, depending on thickness. Parts molded from these resins are almost as good in this respect at 390 F as at room temperature.

For longer periods of moderate electric stress, tetrafluoroethylene resins are superior to many organic materials, being unaffected by ozone and ultraviolet light, which accompany corona bombardment. However, Teflon will be eroded, as will other organic materials. Recommended working stresses are therefore normally 50-100 v per mil, typical of those used in the design of motors and generators operating at below 2300 v. For higher voltages, corona should be minimized by special designs.

Addition of reinforcing agents to tetrafluoroethylene plastic increases dielectric constant and dissipation factor and decreases dielectric strength, volume, and surface resistivity. Arc resistance may remain unchanged or reduced depending on the nature of the reinforcing agent.

▶ Miscellaneous Properties

Weathering: Parts fabricated of tetrafluoroethylene are virtually unaffected by weather. Conclusive tests on samples exposed for 10 years to practically all climatic conditions confirm these weather resistant properties. Resistance to extreme heat and cold, and ultraviolet light, is excellent.

Permeability: Sheet molded of Teflon has a permeability comparable to neoprene and butyl rubber, which are widely used for lining pipe and equipment. This low permeability combined with excellent chemical resistance makes an excellent material for lining piping and equipment for severe corrosive service at temperatures to 500 F.

Permeability rates for sheets molded of tetrafluroethylene resin exposed to several gases and vapors are shown in Fig. 41.

Vibration Damping: Molded tetrafluoroethylene plastics have excellent vibration damping properties at both sonic and ultrasonic frequencies. Installations for this purpose have been very successful. Thickness of material required must be sufficient to absorb the energy produced and is usually determined experimentally.

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3. C. A. Swenson—"Mechanical Properties of 'Teflon' Tetrafluoroethylene Resin at Low Temperatures," *Review of Scientific Instruments*, Vol. 25, No. 8, August, 1954, p. 834.
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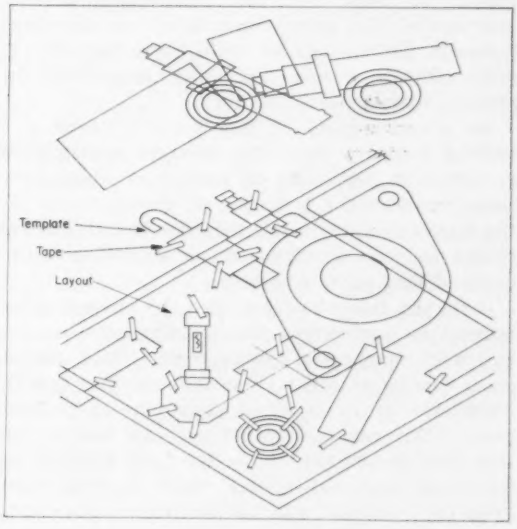
Tips and Techniques

Speeding Component Layout

The problem of locating component parts on a chassis, or doing preliminary layout work, can be simplified by use of two-dimensional mockups. The mockups are drawn to scale on ordinary vellum and reproduced on transparent acetate sheets. The



mockups are then cut out along their contour lines and mounted in place.

Transparency of the mockups permits the designer to observe very clearly relationships (such as distances and interferences) with other components in a layout.—GEORGE FRIEBER, *Bell Telephone Laboratories, Murray Hill, N. J.*

The Personal Side of Engineering

By **EDWIN C. NEVIS**
Personnel Research and Development Corp., Cleveland, Ohio

Developing Managerial Talent

THROUGHOUT business and industry today there is tremendous interest and activity in management development. Many companies have assigned staff and funds to implement development programs; the position of "Director of Management Development" has been added to the roster of executive titles. And there is hardly any middle-sized or big company that is not beating the bushes for bright young "management trainees" to enroll in development programs.

Typically, the main objective of management development programs is to provide a reservoir of trained and experienced men to move into more responsible positions. There is also emphasis upon helping managers to do a more effective job on current assignments. One underlying assumption in all such programs is that management is a profession in itself. Another assumption is that shortage at the management level and increased demands for managerial skills force industry to systematically develop managers instead of depending upon natural selection.

As a consequence of this activity, there is a healthy tendency today for younger management personnel to seek jobs or companies which have some provision for management development. By the same token, there is a tendency in management circles to view development as something which can be dished out in a package.

Certainly this view underlies the current great interest in conferences and training courses as a means of managerial development. Such conferences can be of great value in imparting specific knowledge or in creating awareness of problem areas. But reliance upon them can becloud the fact that development is, in the final analysis, an individual, personal matter which depends more upon the "trainee" and his motivation than upon the "teacher."

Boiled down to its essential elements, management development is a day-to-day activity in which each person really develops himself under the guidance and encouragement of his superiors. Basically, all an organization can do is to create a favorable environment containing opportunities and rewards which motivate people to develop.

The climate in which development takes place is extremely important. This fact has been demonstrated by two significant studies of the subsequent performance of supervisors exposed to human-relations training programs, one by Walker and Guest in an automotive company, and one by the Ohio State Leadership Research Board for the International Harvester Co.

In both cases, human relations skills actually were poorer, rather than better, following a training course. Primary reason was that the insights acquired in training could not be applied because superiors of the persons trained had different values and were not involved in the development program. Thus, in some cases, they were not convinced of the value of the program. In effect, the lack of an encouraging environment led to regression rather than to progress in development.

One significant finding in studies of development and maturation of children is that the child becomes an adult through a process of imitation and identification with encouraging parents, teachers and other adults. Is it not reasonable to suggest that the engineer can learn to become a good manager by emulating and identifying himself with an encouraging, competent superior?

Such an association provides a frame of reference and an opportunity to see at first hand how successful managers perform. When managers provide encouragement and recognition, they motivate people working for them to increase their efforts and skills, as well as to prepare themselves for greater responsibilty.

The implication seems to be quite clear as regards management development programs: Emphasize periodic performance reviews and coaching of subordinates by superiors. A framework should be provided wherein it becomes the accepted thing for managers to guide their juniors onward by a series of developmental assignments, thoroughly reviewed with the man. In this management framework, younger and less experienced engineers can easily and adequately be prepared for management responsibilities. No series of courses can ever take the place of this day-to-day effort by line management to create a climate favorable to growth.

Charts simplify calculation of

Natural Frequencies of Beams

By R. A. DiTARANTO
Defense Electronic Products Div.
Radio Corporation of America
Camden, N. J.

IN THE DESIGN of structural machine members, it is often necessary to find the natural vibration frequencies of these elements to avoid large deflections or stresses due to a resonant condition. Four cases represent the most frequently encountered design situations:

1. Uniform beam with known end conditions.
2. Semiuniform beam with known end conditions.
3. Uniform or semiuniform beams where the end conditions are not fully known.
4. Uniform or semiuniform beams with a concentrated load approximately at the end of a cantilever member or in the center of "fixed-fixed" or simply supported elements.

To aid analysis of these different conditions, a set of charts for rapid graphical solution of natural vibration frequencies has been developed. These charts provide values for either cantilever, simply supported, or fixed-fixed beams of rectangular or tubular cross section. Data are applicable to either aluminum or steel beams.

Nomenclature

A_1 = Frequency factor, dependent on end conditions, for uniform beam with concentrated load
a_1 = Frequency factor, dependent on end conditions, for unloaded uniform beam
b = Width of rectangular cross section, in.
D, D_i = Outside and inside diameters of tubular cross section, in.
E = Modulus of elasticity of beam material, psi
f = Natural frequency of beam, cps
G_s = Correction factor for conversion of frequency values
h = Depth of rectangular cross section, in.
I = Moment of inertia of beam cross section about neutral axis, in.^{4}
L = Beam length, in.
R = Outside radius of tubular beam, in.
s = Load factor dependent on end conditions
t = Wall thickness of tubular beam, in.
W_b = Weight of beam, lb
W = Concentrated or distributed load on beam, lb
γ = Density of beam material, lb per cu in.
ρ = Weight of beam material per unit length, lb per in.

Range of application of the chart data includes beams without load, with a concentrated load or with a distributed load. The charts are also useful in "bracketing" the natural frequency of a beam with end conditions between fixed-fixed and simply supported. For semiuniform beams, an average stiffness (EI) value and average weight may be used as a basis for solution.

For problem solutions with these charts, only these factors need be known: (1) length and cross-section depth of rectangular beams or (2) length, OD and wall thickness of tubular beams.

Basic Concepts: Fundamental expression for natural vibration frequency of a beam is

$$f = a_1 \left(\frac{EI}{\rho L^4} \right)^{1/2} \quad (1)$$

where symbols are defined in Nomenclature.

For a beam of rectangular cross section,

$$I = \frac{bh^3}{12} \quad (2)$$

and

$$\rho = bh\gamma \quad (3)$$

Combining Equations 1, 2 and 3 gives

$$f = \frac{a_1 h}{L^2} \left(\frac{E}{12\gamma} \right)^{1/2} \quad (4)$$

Since the value of ratio E/γ is about the same for aluminum and steel, the only variable for beams of these materials under a given set of end conditions is h/L^2. Reference Curve 1 of the chart in Fig. 1 is based on this relationship.

For a beam of tubular cross section,

$$I = \frac{\pi (D^4 - D_i^4)}{64} \quad (5)$$

and

$$\rho = \frac{\pi\gamma (D^2 - D_i^2)}{4} \quad (6)$$

Combining Equations 1, 5 and 6 and simplifying gives

$$f = \frac{a_1 D}{4L^2} \left\{ \frac{E}{\gamma} \left[1 + \left(1 - \frac{t}{R} \right)^2 \right] \right\}^{1/2} \quad (7)$$

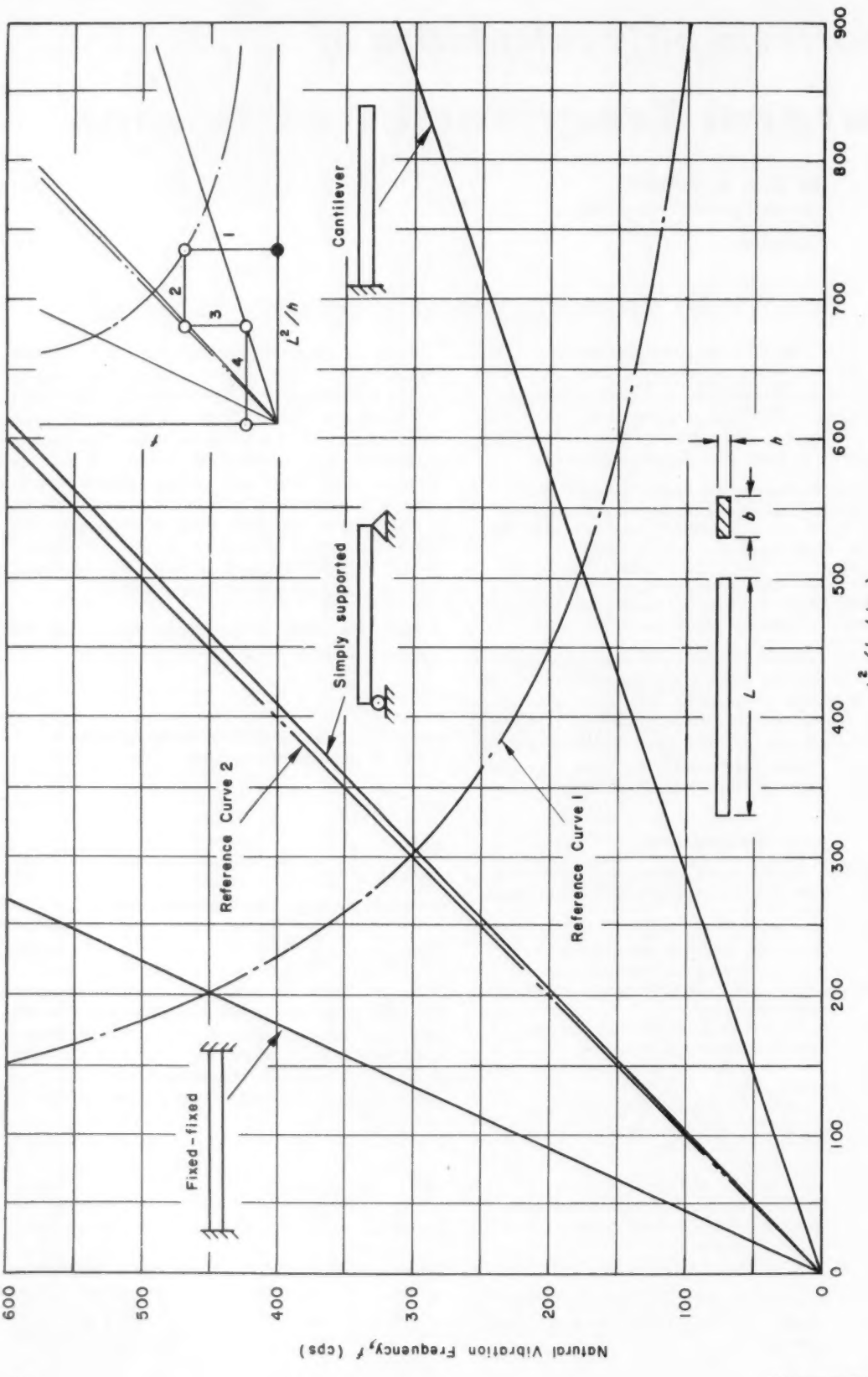


Fig. 1—Natural vibration frequency chart for unloaded uniform beams of rectangular cross section. Curves are based on steel or aluminum. Legend shows solution for cantilever beam.

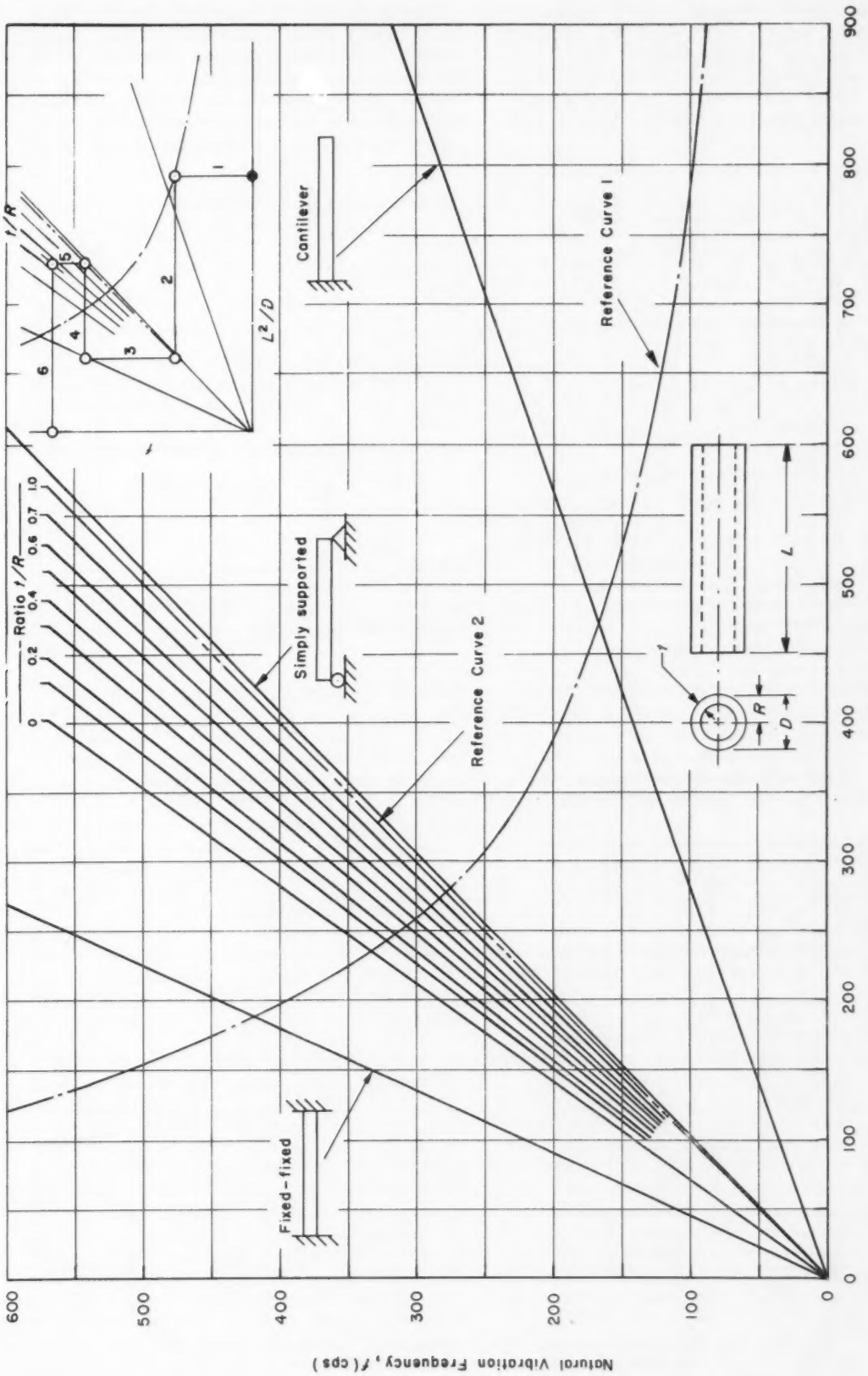


Fig. 2—Natural vibration frequency chart for unloaded uniform beams of tubular cross section. Curves are based on steel or aluminum. Legend shows solution for fixed-fixed beam.

Thus, for tubular aluminum or steel beams, the only variables under a given set of end conditions are D/L^2 and t/R. In the chart of Fig. 2, Reference Curve 1 corresponds to the values of D/L^2 while the family of sloping straight lines radiating from the origin represents different values of ratio t/R.

These expressions for fundamental natural vibration frequency apply to unloaded uniform beams. Effect of a specifically located concentrated load on these frequency relationships is given in Fig. 3. Corresponding relationship for an evenly distributed load added to the beam is shown in Fig. 4.

Based on Rayleigh's method, the natural vibra-

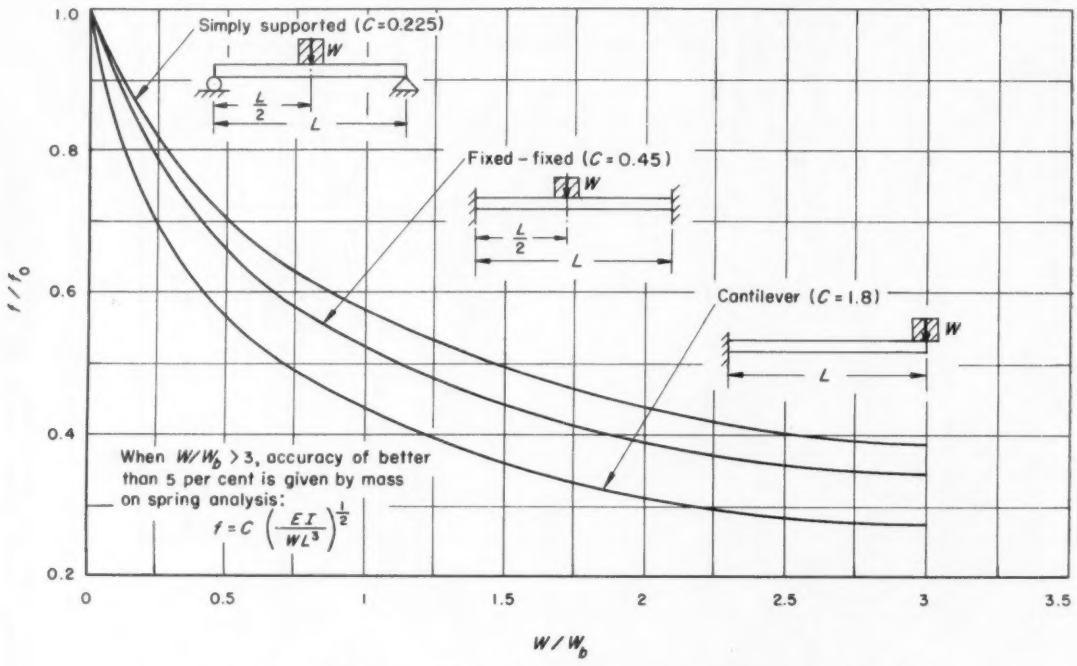


Fig. 3—Natural vibration frequency chart for uniform beams with a concentrated load. Values of f_o for rectangular and tubular beams are given by the charts in Figs. 1 and 2.

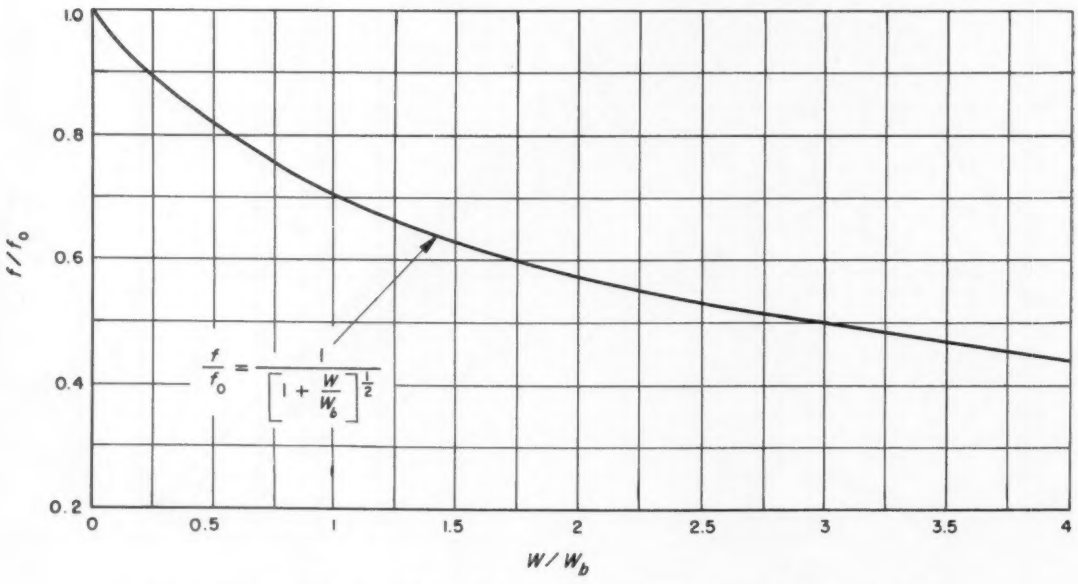


Fig. 4—Natural vibration frequency curve for all uniform beams with evenly distributed load. Values of f_o for rectangular and tubular beams are given by the charts in Figs. 1 and 2.

tion frequency for a uniform beam with concentrated load is

$$f = \left(\frac{A_1 \frac{EI}{W_b L^3}}{1 + s \frac{W}{W_b}} \right)^{1/2} \quad (8)$$

Factors A_1 and s are dependent upon the beam end conditions. When $W = 0$, Equation 8 is simplified to

$$f = \left(A_1 \frac{EI}{W_b L^3} \right)^{1/2} \quad (9)$$

This relationship suggests the possibility of using the frequency values from the charts for unloaded beams, Figs. 1 and 2, and multiplying by a conversion factor G_s to find the frequency with a concentrated load. From Equation 8, then,

$$G_s = \left(\frac{1}{1 + s \left(\frac{W}{W_b} \right)} \right)^{1/2} \quad (10)$$

The curves in Fig. 3 represent plots of this factor for varying load-weight ratio (W/W_b) in cantilever, fixed-fixed and simply supported beam members.

Chart Solution: Use of the charts in determining natural vibration frequencies for four cases is outlined in the following sections:

UNLOADED UNIFORM RECTANGULAR BEAM: For given length L and cross-section depth h, fundamental natural vibration frequency of a rectangular beam may be determined from Fig. 1 by the following procedure:

1. Calculate value of L^2/h and locate this point on Reference Curve 1.
2. From the point on Reference Curve 1, draw a line parallel to the L^2/h-axis, intersecting Reference Curve 2.
3. From the point on Reference Curve 2, draw a line parallel to the f-axis, intersecting the line corresponding to the particular beam end condition.
4. Read natural vibration frequency of the beam as the ordinate of the point found in the preceding Step 3.

Example: Find the natural vibration frequency of a rectangular beam in which $L = 20$ in. and $h = 1$ in. On Reference Curve 1, Fig. 1, locate the point corresponding to $L^2/h = 400$ in.; ordinate of this point is $f = 223$ cps. From this point, draw a line parallel to L^2/h-axis, intersecting Reference Curve 2 at abscissa $L^2/h = 223$ in. Through this intersection, draw a line parallel to f axis, intersecting lines for different end conditions. Read fundamental natural vibration frequency $f = 80$ cps for cantilever beam, 221 cps for simply supported beam, and 500 cps for fixed-fixed beam.

UNLOADED UNIFORM TUBULAR BEAM: For given outside diameter D, wall thickness t and length L, fundamental natural vibration frequency of a tubular beam may be determined from Fig. 2 by the following procedure:

1. Calculate value of L^2/D and locate this point on Reference Curve 1.
2. From the point on Reference Curve 1, draw a line parallel to the L^2/D-axis, intersecting Reference Curve 2.
3. From the point on Reference Curve 2, draw a line parallel to the f-axis, intersecting the line corresponding to the particular beam end condition.
4. From the point of intersection, draw a line parallel to the L^2/D-axis, intersecting Reference Curve 2.
5. From the second point on Reference Curve 2, draw a line parallel to the f-axis to intersect the line corresponding to ratio t/R for the specific beam.
6. Read natural vibration frequancy of the beam as the ordinate of the point found in the preceding Step 5.

Example: Find the natural vibration frequency of a tubular beam where: $L = 20$ in., $D = 0.8$-in. and $t = 0.12$-in. On Reference Curve 1, Fig. 2, locate $L^2/D = 500$ in.; ordinate of this point is $f = 152$ cps. From this point, draw a line parallel to L^2/D-axis, intersecting Reference Curve 2 at $L^2/D = 152$ in. Continue this point-to-point-procedure from Reference Curve 2 to end condition, from end condition back to Reference Curve 2, and finally, from Reference Curve 2 to the line corresponding to $t/R = 0.3$. Read fundamental natural vibration frequency $f = 65$ cps for cantilever beam, 185 cps for simply supported beam, and 425 cps for fixed-fixed beam.

UNIFORM BEAM WITH CONCENTRATED LOAD: Consider the case of a rectangular cantilever beam, such as analyzed in the first example, where: $L = 20$ in., $h = 1$ in., and $L^2/h = 400$ in. If the beam weighs 0.75-lb and a concentrated load of 1.3 lb is applied at the free end, the natural vibration frequency can be obtained in the following manner.

From Fig. 1, as covered in the first example, find the natural vibration frequency of the unloaded beam as $f_0 = 80$ cps. Ratio $W/W_b = 1.3/0.75 = 1.735$. From Fig. 3, using the cantilever-beam curve, find $f/f_0 = 0.34$. Thus, natural vibration frequency of the beam with a concentrated load at the free end is $f = 80\ (0.34) = 27.2$ cps.

UNIFORM BEAM WITH DISTRIBUTED LOAD: For the same rectangular cantilever beam analyzed in the foregoing discussion, consider the case in which the concentrated load is replaced by a uniformly distributed load, $W = 1.3$ lb. From Fig. 1, $f_0 = 80$ cps. Also, ratio $W/W_b = 1.735$. From Fig. 4, find $f/f_0 = 0.6$. Thus natural vibration frequency of the beam with a distributed load is $f = 80\ (0.6) = 48$ cps.

Applications and properties of

Thermenol Alloys

By J. F. NACHMAN and W. J. BUEHLER
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White Oak
Silver Spring, Md.

On the basis of strength-weight ratio, Thermenol shows better strength properties above 450 F than many aircraft structural materials including titanium and stainless steel.

IT may be possible for Thermenol to serve as a replacement for Type 403 stainless steel. It has advantages of 15 per cent lower density, excellent high-temperature stress-rupture strength, and superior resistance to corrosion. Thermenol is an Fe-Al-base alloy containing approximately 10 to 18 per cent Al, 2 to 4 per cent Mo, and the remainder Fe.

Physical and Mechanical Properties: Physical properties of Thermenol are listed in Table 1, and mechanical properties at room temperature are listed in Table 2 with those of Type 403 stainless steel for comparative purposes. Specimens with the greatest amount of cold work exhibit best tensile properties and attain an ultimate tensile strength of 142, 800 psi for 0.003-in. sheet. Hot-tensile properties of Thermenol are shown in Table 3.

Instead of decreasing as temperature rises, tensile strength of Thermenol actually increases. Ultimate tensile strength of Type 403 stainless steel at 1000 F drops to approximately one-half room-temperature value. Above 450 F, strength-to-weight ratio of Thermenol exceeds even that of 17-7 PH stainless steel.

Magnetic Properties: Highest permeabilities and best overall static magnetic properties are obtained from Fe-Al-Mo alloys containing approximately 3.3 per cent Mo and 15 to 16 per cent Al. Magnetic properties of Thermenol alloys drop to rather low values at approximately 17 per cent Al. At 18 per cent Al, the alloy structure is practically paramagnetic. Also, an alloy containing 17.2 per cent Al, when annealed and furnace cooled, exhibits constant permeability properties.

Corrosion Properties: Resistance of Thermenol to corrosion by highly oxidizing solutions is excellent. Accordingly, resistance to fuming nitric acid is exceptionally good, and compares favorably with

Table 1—Physical Properties of Thermenol

Density	6.58 gm per cu cm
Resistivity	162 mu ohm-cm, 0.020 in. sheet
Modulus of elasticity	26,000,000 psi
Thermal conductivity	6.3 Btu/sq ft/hr/deg F/ft
Coefficient of thermal exp (68 to 1300 F)	0.000011 in./in./deg F
Compressive strength (psi at 0.1 per cent set)	86,100

Table 2—Mechanical Properties of Thermenol at Room Temperature

Material	Ultimate Ten Str (psi)	Yield Strength (psi)	Elongation (per cent)
Cold-rolled sheet:			
0.003 in.	107,000	94,000	6
0.008 in.	114,000	113,000	1.5
0.016 in.	121,500	119,500	1
0.020 in.	80,000	.....	1
0.032 in.	115,500	109,500	1
Rolled bar annealed at 1925 F	90,000	71,300	3.7
Duraloy cast annealed at 1925 F	102,000	94,000	1
Type 403 stainless bar	123,000	105,300	23.3

Table 3—Tensile Properties of Thermenol at Elevated Temperatures

Material	Temperature (F)	Ultimate Ten Str (psi)	Yield Strength (psi at 0.2 offset)	Elongation (per cent)
Cold-rolled sheet, 0.008 in.	400	158,600	112,750	10
	600	134,000	102,000	15
	900	118,850	97,150	7
	1100	69,350	.....	1
Hot-rolled plate	500	58,000	.....	1.8
	800	68,000	.....	5.4
	1000	67,000	.....	...
	1200	53,000	.....	16.6
Type 403 stainless bar	500	108,200	92,400	18.3
	600	107,100	90,500	17.5
	800	89,500	77,800	21.8
	1000	62,200	56,800	29.3
	1200	28,300	24,800	30.5

higher cost alloys. Sodium hydroxide, organic acids, and concentrated ammonium hydroxide have negligible effects on Thermenol. However, ferric chloride and hydrochloric acid are corrosive. At high temperatures, Thermenol alloys have an oxidation resistance superior to all other known high-temperature alloy systems.

Applications: The following general applications for Thermenol are suggested:

1. High-strength structural parts for exposure to at least 1200 F.
2. Oxidation-resistant parts for high-temperature use.
3. Corrosion-resistant parts which must fully resist acids and sulfur atmospheres.
4. Parts with high resistivity and excellent magnetic properties for high-frequency transformers, magnetic shielding, recording heads, etc.
5. Parts with low heat conductivity for high-temperature installations.
6. Parts with low neutron cross-section for nuclear installation.

From "Applications, Properties, and Fabrication of Thermenol Type Alloys," U. S. Naval Ordnance Laboratory Report 4237, PB 121098. Distributed by Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

Evaluating Design Changes

Visual presentation of design trends aids designers in all phases of product development

TREND charts, or progress charts, are means of tabulating in graphic form the effectiveness of equipment over periods of time. Fig. 1, for example, shows overall life improvement of the DC-7 cabin supercharger during the last few years. Fig. 2 includes the curve of Fig. 1 and, in addition, gives a graphical representation of other supercharger models undergoing development.

Analysis of the graphs indicates peak performance of units in the second quarter of the year, adverse effects of hot-weather operation due to increased cooling demands, times at which design changes were made, nature of changes, and results. Effectiveness of these changes is evident from the rise of the curve over a long period of time.

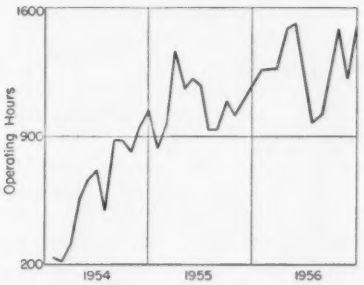


Fig. 1—Improvement of overhaul life for DC-7 aircraft supercharger

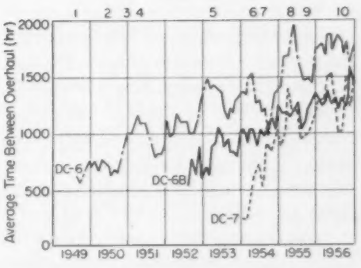


Fig. 2—Improvment of average overhaul life of DC-6 and DC-7 aircraft superchargers

These charts are effective aids in design-development programs. They enable designers to see trends in phases of product development, depending on which data are used in compiling them.

From ASME paper 57—SA—36 entitled "The Mechanical Design Approach to Simplified Maintenance," presented at the ASME Semi Annual Meeting in San Francisco, June, 1957, by G. W. Cameron and J. W. Rupp, Douglas Aircraft Co., Santa Monica, Calif.

Ceramic Insulating Materials

for high-temperature use

By W. D. KINGERY, J. D. KLEIN, and M. C. McQUARRIE

Massachusetts Institute of Technology, Cambridge, Mass.
Pennsylvania State University, University Park, Pa.

Factors affecting thermal conductivity of ceramics in the temperature range from 2200 to 4000 F are considered from the point of view of high-temperature insulation. Effective conductivity of solid and porous materials over a wide range of temperatures is analyzed.

CRYSTALLINE composition of ceramics becomes less important as temperature increases, but effect of thermal radiation through solids is becoming the predominant mechanism of heat transfer at high-temperature levels. Glasses and clear single crystals have a low absorption coefficient for visible and near-infrared radiation which become predominant wave lengths at moderately high temperatures, even though they may be substantially opaque to the far infrared which is predominant at lower temperatures. Polycrystalline ceramics, such as porcelains, are sufficiently translucent so that energy transfer becomes important at temperatures above 3000 F.

Fused silica is a good thermal insulator at room temperature and alumina ceramics are relatively good thermal conductors. Owing to the effects of thermal radiation, they have the same effective conductivity at 2000

F. Since radiation conductivity depends on the third power of temperature, it becomes important at higher temperatures and is expected to have a pronounced effect on behavior of insulators as the temperature level is raised.

Measurements of the absorption coefficient of sapphire crystals over a wide temperature range show only minor changes. Since high-temperature radiation is mainly in the visible and near-infrared, observation of room-temperature transparency or translucency can be used as a guide to effects at higher temperatures. Transparent glasses and crystals show influence of radiation conduction at temperatures of 700 to 2000 F. Translucent oxides roughly equivalent to bone china or milk glass, show effects of radiation conduction at 2000 to 2600 F.

Importance of these effects at higher temperatures is difficult to evaluate precisely. The best experimental data available indicate that conductivity due to radiation in polycrystalline aluminum oxide, magnesium oxide, and beryllium oxide increases proportionately to the eighth power of temperature. However, analysis indicates that a third or fourth-power relationship is more probable, and this has been observed for fused quartz and single crystals. In either case, effective conductivity of translucent or transparent solids at high temperatures may be several times larger than true thermal conductivity.

Chemical and crystallographic composition of solids becomes less important to thermal conductivity at high temperatures, and the absorption coefficient for visible and near-infrared radiation may become very important.

High-temperature insulating brick for use up to 2800 F, has a conductivity which increases from 0.0005 at 500 F to 0.0008 at 1400 F. The increase corresponds to slightly more than that due to increase in air conductivity. Pore size is approximately 0.05 to 0.08 in., so that conductivity is expected to increase markedly at elevated temperatures. Thermal conductivity of powder and fiber insulation varies substantially, depending on powder characteristics. In both cases, results are sensitive to porosity and temperature.

In the case of powders and fibrous insulation, major considerations are small pore size and opacity. As long as pore size is below 0.004 in., effective conductivity due to gas conduction and radiation is less than 0.0004 at 4000 F. This requires a powder of approximately minus 150 mesh which is substantially finer than material normally used at lower temperatures. Tighter packing of powder has two effects: Effective volume of pore space is decreased, tending to increase conductivity; while effective pore size is decreased, tending to lower conductivity. The net result depends on pore size and temperature.

If gas conduction is the predominant process of heat transfer, increased packing will be deleterious. If radiation is the predominant process of heat transfer across pores, packing will improve insulation since average pore width decreases more rapidly than volume fraction porosity. Due to increasing importance of radiant-heat transfer, it is desirable to have opaque powder for high-temperature insulation.

One of the difficulties of using powder insulation at high temperatures is that need for fine particles introduces the possibility that sintering will occur at contact points, leading to better heat transfer. It is preferable to use materials which do not sinter. However, these are restricted to graphite, silicon carbide, and boron nitride, all of which must be used in reducing atmospheres. At high temperatures, translucency of boron nitride makes it the least effective insulator. Any of the oxide materials will sinter at the contact points at 4000 F, thereby reducing efficiency of the insulation. There are no powders or fibers which can be used in air for any length of time at temperatures near 4000 F without changing in structure.

Extremely fine particle sizes are not necessary to reduce the contribution of gas conduction at atmospheric pressure. For high temperatures, extremely fine powders are best avoided. It has been observed that solids are better than porous bodies at high temperatures. This is not always true. however, since for pore sizes below 0.1 in., effective conductivity due to conduction and radiation is lower than the conductivity of the best solid insulators at temperatures below 4000 F.

From ASME paper 57—HT—15 *entitled "Development of Ceramic Insulating Materials for High-Temperature Use," presented at the ASME-AIChE Conference in University Park, Pa., August*, 1957.

New designs in *Circuit-Protection Relays*

By G. J. MARIENI AND W. STEPANUK
Relay Engineering
Westinghouse Electric Corp.
Newark, N. J.

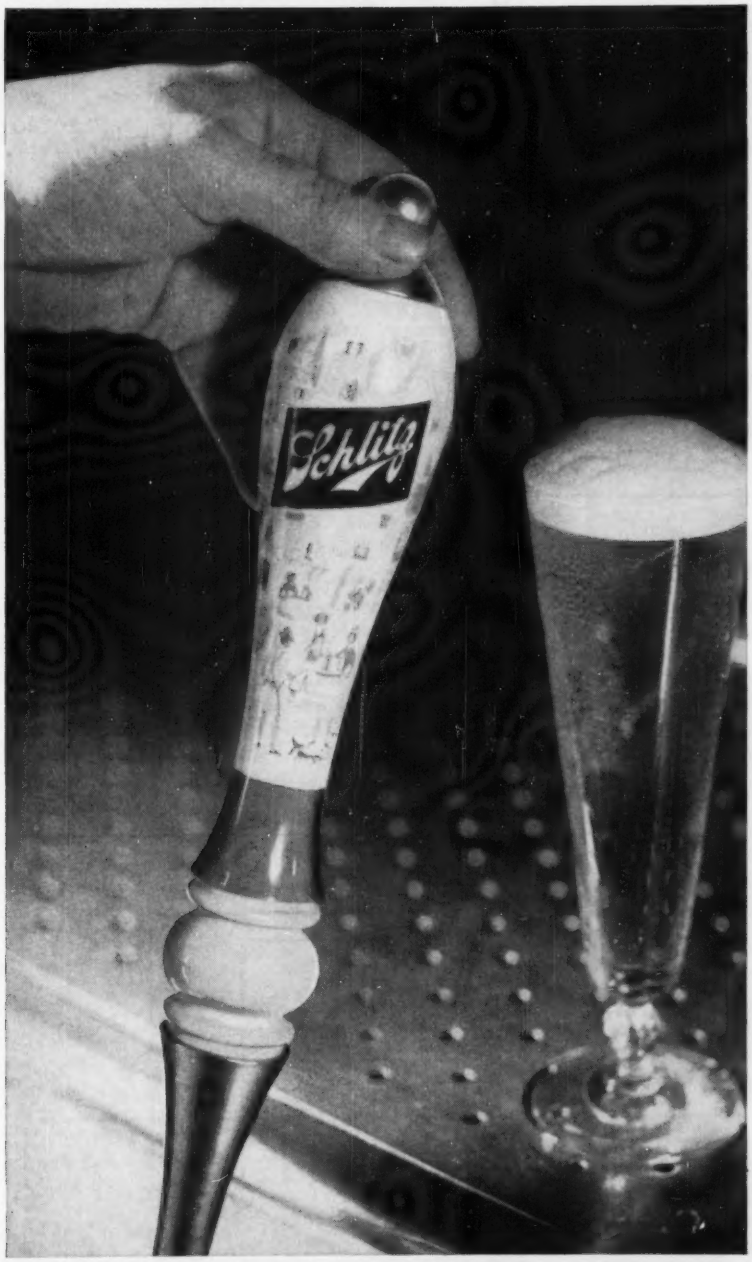
PROTECTIVE relays function to prevent damage to power-system apparatus during fault or overload conditions, and reduce the effect of these abnormal conditions on an electrical-system operation.

Each of three new types of protective relays utilizes two significant operating units, i.e., an electromagnet for overcurrent or over-voltage detection, and a cylinder-type directional unit for detecting power flow direction.

Overcurrent Relays: The over-

Classic decorated porcelain simulated for the first time in

NEW MELAMINE Schlitztap



NEW "SCHLITZTAP" consists of three melamine parts—handle collar, color band, and decorated section. These are assembled on a threaded aluminum rod and held between an anodized aluminum shank and crown. This striking draught-beer sales aid stands a handsome 12" high, carries two gay, five-color village street scenes. It looks like the finest bone china.

"Fused-in" decorations now possible on complex shapes, says Chicago Molded... and here's how it's done:

The design and production of the beautiful new "Schlitztap" is the result of more than two years of intensive research by the Jos. Schlitz Brewing Co., and by Hammer Bros., Inc. A solution to the complex problems involved in molding the tap handles was provided by Chicago Molded who engineered and molded the plastic parts.

A milestone in plastics technology, the "Schlitztap" represents the first time that a compound curved melamine surface has been decorated on a production-line basis. And with this type of decoration, the design is fused right into the melamine. It's virtually indestructible—immune to perspiration, scratching, staining or chipping.

Paves way for new applications. Most important, the "Schlitztap" represents a breakthrough for plastics into the field of decorated ceramics. It suggests parts ranging from decorated containers and giftwares, to lamp bases and door knobs—all made of beautiful, break-resistant melamine.

How it's done. Among the technical molding problems overcome by Chicago Molded was appearance of bubbles on the decorated surface, mottling of colors, and "burning out" of the pastel tones. Using a dual cycle operation, each piece is molded in a horizontal position on a 170-ton transfer press. During the first phase, melamine is forced into the die and allowed to pre-cure. The mold is then opened for positioning of two melamine foil overlays. Then there's a final curing cycle and the decoration becomes an integral part of the completed handle.

Whatever your plastic molding needs, you'll find it pays to call in Chicago Molded. CM engineers keep abreast of the progress in plastics, often *create* that progress to help you make your product more saleable. *That's why 66% of our business comes from firms we've served for over 20 years.*

For your free subscription to Plastics Progress, CM's magazine on up-to-date developments in plastics, write today to:

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1028 North Kolmar Avenue, Chicago 51, Illinois

Circle 474 on page 19

current relay operates on the induction-disc principle. An electromagnet produces a torque, causing rotation of the induction disc, Fig. 1. The moving contact of the relay is clamped to an insulated portion of the disc shaft. During an overload, the disc rotates until contact is made with the stationary contact, and the trip circuit energizes. A damping magnet restrains motion of the disc and is partially responsible for the characteristic of the operating-time curve.

A newly designed electromagnet, combined with an Alnico permanent magnet for damping, provides seven different operating - time curves without gearing.

The new Alnico damping magnet is permanently located with respect to disc center point, with the drag of the magnet on the disc controlled by varying the keeper which controls the amount of flux cutting the disc. The more flux cutting the disc, the slower the disc speed for a given operating current applied to the main coil.

The disc is spiral-shaped to compensate for spiral spring wind-up, and introduces a greater amount of disc surface or driving medium into the electromagnet gap as the disc rotates toward the contact-closed position. Thus, accurate operating time is assured over the entire range of the operating-time curve.

Operating-time characteristics of these relays are calibrated by adjustment of spiral control-spring tension, damping magnet drag, and magnetic plugs in the electromagnet flux path. Taps are provided on the main-coil winding to select desired current-transformer pickup current. The time dial provides a means of setting total travel for the rotating disc. Minimum pickup point is obtained by balancing the effect of control-spring restraint against electromagnet operating torque. The characteristic of the operating curve at low-current values is controlled by adjustment of the permanent magnet keeper, while at high currents, the operating characteristic is adjusted by controlling saturation of the electromagnetic circuit with the magnetic plugs.

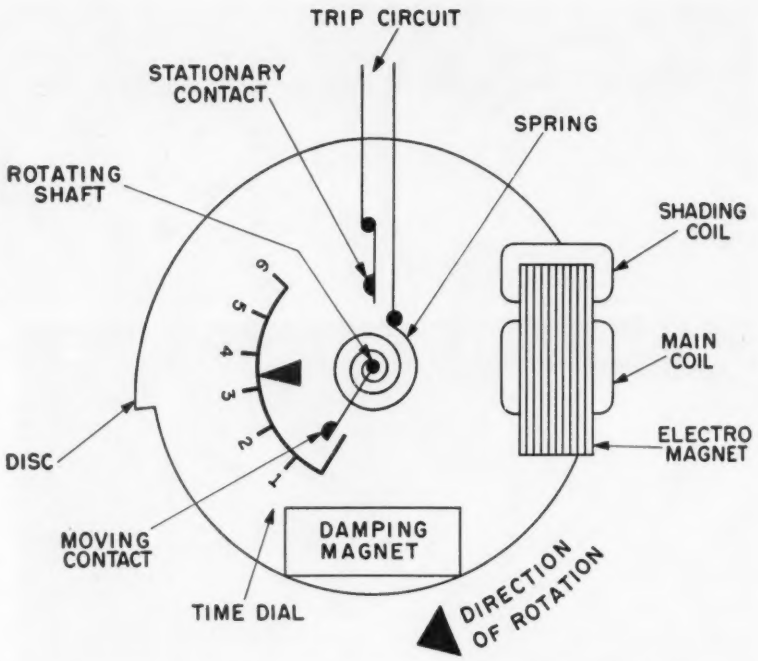


Fig. 1—Fundamental components of the induction-type time-delay relay. Operating torque produced by the electromagnet moves disc against tension of coiled spring. The damping magnet provides restraint when disc is moving. Total disc movement is set by adjusting the starting position of the disc with the time-dial stop.

A schematic diagram of the new Westinghouse overcurrent relay is shown in Fig. 2.

Directional Overcurrent Relays: Modern relay systems often call for protective relays that trip only when power flows in a given direction. By combining a directional unit with an overcurrent unit, the relay becomes sensitive to current direction and magnitude. New directional overcurrent relays combine a directional unit with the overcurrent unit. The directional unit has speed, freedom from vibration at high current, plus a controlled phase-angle and sensitivity curve.

The directional unit is held in

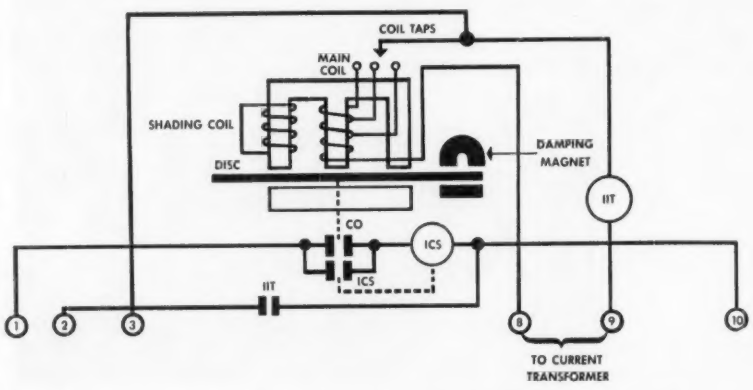


Fig. 2—Schematic diagram of new type overcurrent relay. When overcurrent occurs, disc closes CO contact. This energizes ICS (indicating contactor switch coil), and ICS contacts also close, shunting CO contacts. On extremely high overcurrents, IIT (indicating instantaneous trip coil) picks up, closing IIT contacts.

Now! A Complete Line of Self-Locking Microsize UNBRAKO Socket Cap and Set Screws

Nos. 0, 1, 2 and 3 in alloy steel and stainless steel are available with the Nylok* feature

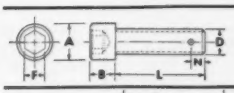
You effect major economies in time and money when you design and assemble small devices with self-locking microsize UNBRAKO socket screws. These close tolerance screws won't work loose. They simplify standardization of small devices where maximum reduction of weight is required without sacrifice of strength. They eliminate the necessity of designing costly special screws to fasten tiny parts in compact assemblies and they prevent the waste of production time while waiting for delivery of special screws.

In addition to having the overall advantages of microsize UNBRAKO socket screws, these screws can be used in holes tapped in soft or die cast materials without stripping threads and ruining expensive work. Also the set screws can be used with hardened shafts, since they lock against the threads of the tapped hole.

All UNBRAKO socket screws can be supplied with the self-locking Nylok feature. The UNBRAKO with Nylok is a single self-locking unit. No auxiliary locking devices are needed. Seated or not, the screw locks positively wherever wrenching stops, won't work loose—because the tough resilient nylon pellet forces mating threads together.

Ask your authorized industrial distributor for details today. He carries complete stocks of self-locking UNBRAKO socket screws (caps and sets from #0 through 1 in., button heads #4 through ⅝ in., flat heads from #4 through ¾ in.). Or write us for literature and samples. Unbrako Socket Screw Division, STANDARD PRESSED STEEL Co., Jenkintown 18, Pa.

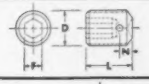
*T.M. Reg. U.S. Pat. Off., The Nylok Corporation



HEAT-TREATED ALLOY STEEL
Self-Locking Microsize UNBRAKO Socket Cap Screws
Class 3A Threads

Screw Size		Threads per in. NC	Threads per in. NF	L Over-all Length	N Pellet Location NC	N Pellet Location NF	Torque Max. prev. on	Torque 1st off stat. min.	Torque 5th off stat. min.
#0	A .104	—	80	1/8	—	.047	5.5	14.0★	7.0★
	B .060	—	80	3/16	—	.047	5.5	14.0★	7.0★
	D .060	—	80	1/4	—	.047	5.5	14.0★	7.0★
	F .050	—	80	3/8	—	.047	5.5	14.0★	7.0★
#1	A .118	—	72	1/8	—	.047	11.0	28.0★	14.0★
	B .073	—	72	3/16	—	.047	11.0	28.0★	14.0★
	D .073	—	72	1/4	—	.047	11.0	28.0★	14.0★
	F .050	—	72	3/8	—	.047	11.0	28.0★	14.0★
#2	A .140	56	—	3/16	.063	—	24.0	3.0	1.5
	B .086	56	—	1/4	.063	—	24.0	3.0	1.5
	D .086	56	—	3/8	.063	—	24.0	3.0	1.5
	F 1/8	56	—	1/2	.063	—	24.0	3.0	1.5
#3	A .161	48	—	3/16	.063	—	40.0	6.5	3.0
	B .099	48	—	1/4	.063	—	40.0	6.5	3.0
	D .099	48	—	3/8	.063	—	40.0	6.5	3.0
	F 3/16	48	—	1/2	.063	—	40.0	6.5	3.0

★Measured in in.-gm. (those not marked with a star are measured in in.-oz.)



HEAT-TREATED ALLOY STEEL
Self-Locking Microsize UNBRAKO Socket Set Screws
Class 3A Threads

Screw Size		Threads per in. NC	Threads per in. NF	L Over-all Length	N Pellet Location NC	N Pellet Location NF	Torque Max. prev. on	Torque 1st off stat. min.	Torque 5th off stat. min.
#0	D .060	—	80	3/32	—	.047	5.5	14.0★	7.0★
	F .028	—	80	1/8	—	.047	5.5	14.0★	7.0★
		—	80	5/32	—	.047	5.5	14.0★	7.0★
		—	80	3/16	—	.047	5.5	14.0★	7.0★
		—	80	1/4	—	.047	5.5	14.0★	7.0★
#1	D .073	—	72	1/8	—	.062	11.0	28.0★	14.0★
	F .035	—	72	5/32	—	.062	11.0	28.0★	14.0★
		—	72	3/16	—	.062	11.0	28.0★	14.0★
		—	72	1/4	—	.062	11.0	28.0★	14.0★
#2	D .086	56	—	1/8	.062	—	24.0	3.0	1.5
	F .035	56	—	5/32	.062	—	24.0	3.0	1.5
		56	—	3/16	.062	—	24.0	3.0	1.5
		56	—	1/4	.062	—	24.0	3.0	1.5
#3	D .099	48	—	5/32	.093	—	40.0	6.5	3.0
	F .050	48	—	3/16	.093	—	40.0	6.5	3.0
		48	—	1/4	.093	—	40.0	6.5	3.0

★Measured in in.-gm. (those not marked with a star are measured in in.-oz.)

Self-locking microsize UNBRAKO socket cap and set screws are available in sizes #0 through #3, in heat treated alloy steel (plated or unplated) and stainless steel, at your authorized industrial distributor. He also carries a complete stock of other self-locking UNBRAKO socket screws.

We also manufacture precision titanium fasteners. Write for free booklet.

SPS **Jenkintown • Pennsylvania**

Standard Pressed Steel Co. • The Cleveland Cap Screw Co. • Columbia Steel Equipment Co., Inc. • Cooper Precision Products • Standco Canada Ltd. Unbrako Socket Screw Co., Ltd.

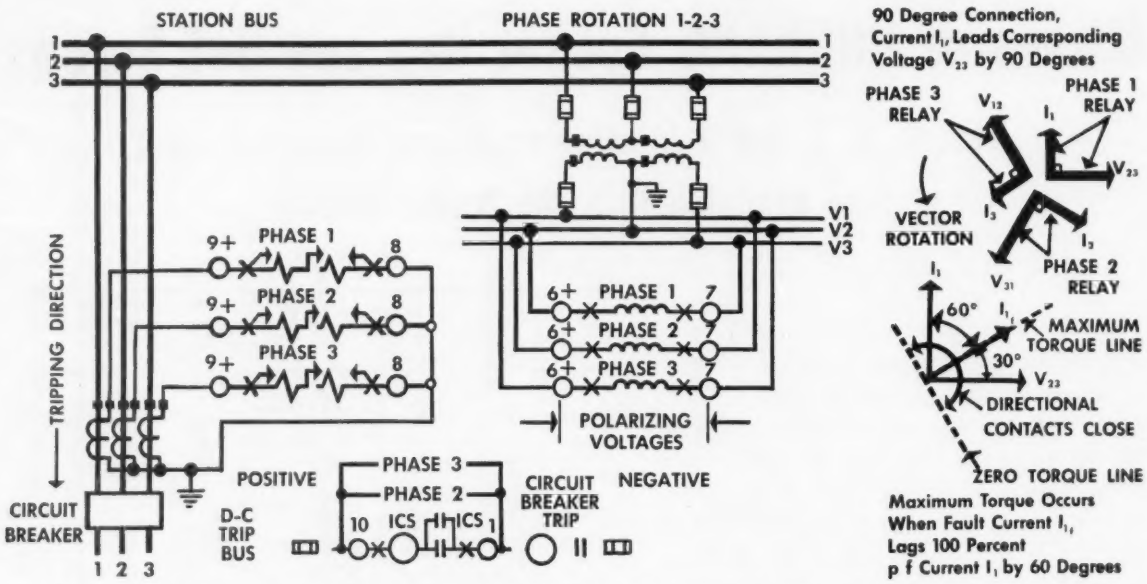


Fig. 3—Left—Application of directional overcurrent relays for phase protection. Three single-phase relays are used. Right—Polarizing-voltage and operating-current vectors are shown for 100-per cent power factor (top) and fault (bottom) conditions.

open-contact position by a spiral spring when de-energized. When polarizing and operating circuits are energized in the proper direction, the cylinder rotates to close operating contacts.

Vibration is an important design consideration since it affects required operating time of the overcurrent unit which is directionally controlled by contacts of the directional unit. Effective vibration is magnified as zero-torque line is approached. Vibration of the moving element of the directional unit at high currents is eliminated by an aluminum-cylinder element instead of a cup-type element. A typical application of the directional unit is shown in Fig. 3. Here, three relays are used, one for each phase, to give directional overcurrent phase protection.

Although all types of phase-directional unit connections have possible areas of undesirable operation, the 90-deg connection affords the greatest degree of reliability. Optimum maximum torque angle of the directional unit occurs when the relay current leads the relay voltage by approximately 30 deg. This maximum torque angle is inherent in the new unit so that no internal phase shifters are required.

The voltage-polarized relay is used for ground-fault protection and operates from residual current and polarizing voltage. Maximum torque angle of these directional units occurs when ground current lags polarizing voltage by approximately 60 deg. An internally-mounted phase shifter obtains maximum torque angle.

Voltage Relays: Former relay designs used a slide-wire resistor to vary initial pickup - voltage value. This resistor has been replaced by a tapped-operating coil on the electromagnet, resulting in higher continuous-voltage ratings for the relay. The new relay, with a nominal rating of 120 v and taps from 55 to 140 v, will withstand a continuous rating of 132 v on all taps except for 140 continuous on the 140-v tap.

A new single relay with a self-contained internal third-harmonic filter is used primarily for protection of ac windings of large generators that are grounded through a distribution transformer. The tuned-filter circuit of this relay offers high impedance to third-harmonic voltage, and low impedance to 60-cycle voltages. The relay does not have taps but is rated 67 v continuously and will pick up on 8 per cent of this value. The relay has adjustable time-dial settings to assure tripping on faults and not transient conditions.

Reduction in sizes of operating units in the relays have permitted a new case design. Primary design changes involve provisions for making the same case suitable for both surface and semiflush mounting. An increase in case depth provides room for auxiliaries such as resistors.

One-piece molded blocks provide a common mounting for switch blades and strap-type connectors to rear metallic connector terminals. This design eliminates the need for independently mounted rear connector terminals and wiring, and greatly facilitates tracing electrical circuits from switch blade to terminals. Required panel-mounting space is reduced.

From "Modern Concepts of Relay Design" in Westinghouse Engineer, *July,* 1957.

HOWELL MOTOR BRIEFS

Quick facts for those who apply and specify electric motors

Installation Facility: Bonus Value in Motors

When you specify electric motors, do you consider their "installation facility" — the ease and freedom from difficulties with which motors can be put in use? It's a bonus value that can cut costs in your final assembly or in your customer's plant (wherever the motors are installed).

Steel Feet, Steel Frames Take Punishment Best

Howell Series 100 motors, with the new, smaller dimensions, have heavy steel feet welded to die-formed steel frames. No cracking of cast iron frame or mounting foot here. When a workman drops a motor down too hard, or applies that last excess twist of a wrench to a mounting bolt, Howell's tough steel frame and mounting feet can take it.

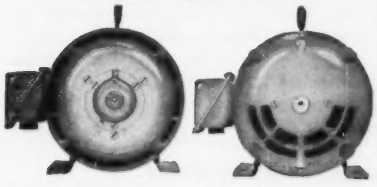
Howell's steel frame construction does much to avoid the delay and expense of motor replacements at the time of final machine assembly.

Position-Identified Leads Insure Correct Wiring

Leads on Howell Series 100 Motors are designated on the nameplate by their positions at the entrance to the conduit box. Each position is identified by an easily read, raised numeral on the neoprene lead block that seals the entrance from the motor. There are no tags, strips or clips to become lost or illegible.

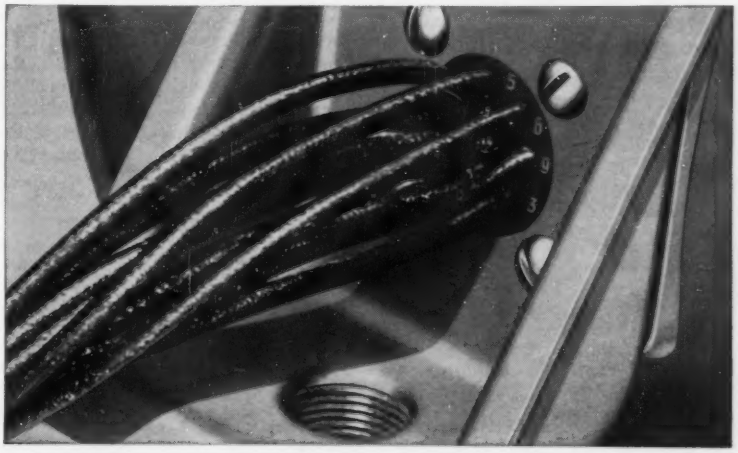
Howell lead identification not only speeds the original installation, it's permanent for easy re-installation, at any time during these motors' long working life.

Interchangeable TEFC and Open Motors



Totally enclosed fan cooled and open-type motors in Howell's Series 100 have the same diameter and mounting dimensions. This simplifies space allocation in your machine designs and allows quick, easy substitution of one type for the other in the field.

Resilient steel feet of Howell motors take any kind of stress during installation. Pads are ground flat after stator assembly to insure perfect mounting alignment.



Howell leads are permanently identified where they enter box from motor. Note time-saving, integral threaded nipple and easy four-way rotation of box to take conduit from any direction.

Get the details on all the bonus features of Howell Series 100 Motors — Write for Bulletin N-100-R

HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

Circle 476 on page 19

Helpful Literature
for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card—page 19

General Utility Stainless

Information on MicroRold 430 stainless sheet and strip given in handbook covers physical properties and analysis, corrosion resistance, surface characteristics, fabrication, application, maintenance and bacterial cleanability, military specifications, and availability. 28 pages. Washington Steel Corp.

Circle 601 on page 19

Pressure Vessel Necks

Comparative costs of seamless forged long welding necks and built-up necks for pressure vessels are appraised in report R8893. Study is based on actual material and labor costs for both types of pressure vessel connections. Costs for 150, 300, 600, and 900-lb necks are plotted. 6 pages. Lenape Hydraulic Pressing & Forging Co.

Circle 602 on page 19

Transmission Products

Transmission products and their uses in elevating and conveying machinery are described in catalog 914. Shaft collars, couplings, clutches, pillow blocks, take-ups, wheel hubs, gears, holdbacks, chains, and sprocket wheels are items covered by drawings and dimensional data. 88 pages. Jeffrey Mfg. Co.

Circle 603 on page 19

Selenium Rectifiers

Technical paper discusses the advantage of "Selenium Rectifiers for High Voltage DC Power Supplies." It shows that in applications in the 1-5 ma load range, selenium circuits are economical. 12 pages. Sorensen & Co., Beta Electric Div.

Circle 604 on page 19

Resistance Wire & Ribbon

Chromel-A, an 80-20 nickel-chromium resistance alloy, is widely used as heating elements in furnaces, industrial heating equipment, ranges, and other electrical heating applications. Catalog M-57A provides metallurgical data and design information on this alloy in resistance wire, ribbon and furnace strip form. 20 pages. Hoskins Mfg. Co.

Circle 605 on page 19

Bronze & Iron Body Valves

Line of bronze and iron body valves described in catalog 57 includes renewable seat ring bronze gate valves, composition disc bronze swing check valves, and solder end globe valves with drain. Technical data for initial design of piping layouts are included. 136 pages. Fairbanks Co.

Circle 606 on page 19

Investment Casting

Care and precision demanded in manufacture of investment castings are outlined in brochure. Advantages of the process are detailed, and the various steps in the casting manufacture are explained. Plant facilities are shown. 16 pages. Hitchiner Mfg. Co.

Circle 607 on page 19

Limit Controllers

Use of Daytronic limit controllers for automatic control of weight, size, force, thickness, pressure, flow, acceleration, stress, strain, or other physical quantities is subject of bulletin 562. 4 pages. Daytronic Corp.

Circle 608 on page 19

DC Microvolt Ammeter

The Kin Tel model 203AR dc microvoltmeter, microammeter, and low level dc amplifier with 15 voltage ranges from 100 microvolts to 1000 v full scale is described in bulletin 16-3. Nineteen current ranges cover from 1 milli-microampere to 1 amp full scale. 2 pages. Kin Tel.

Circle 609 on page 19

Panel Meters

Long scale Weston panel meters available in sizes from 2½ to 5½ in. are subject of descriptive bulletin. In addition to long, readable 250-degree scales, instruments have excellent ballistic characteristics and provide high accuracy. Weston Electrical Instrument Corp.

Circle 610 on page 19

Chain

Tabulated specifications are provided in bulletin 6J/Ta on alloy steel, alloy conveyor and log haul, Hi-test, proof coil, machine, coil, and weldless chain. Tensile strengths range up to 125,000 psi. 4 pages. S. G. Taylor Chain Co.

Circle 611 on page 19

Carbon & Graphite

Properties that make carbon and graphite materials useful for molds, dies, crucibles, sintering boats, and similar items subject to high temperatures are discussed in loose-leaf bulletin. Six charts are included in the bulletin. 8 pages. Speer Carbon Co.

Circle 612 on page 19

Rubber Products

Company facilities for manufacturing rubber parts to customer order are shown in catalog. Emphasis is on production of special molded rubber parts, silicone rubber parts, rubber covered rolls, and rubber-to-metal bonded parts. 12 pages. Williams-Bowman Rubber Co.

Circle 613 on page 19

Forgings & Stampings

How this supplier of forgings and deep drawn stampings integrates modern facilities with customers' needs for new parts, new techniques and new materials is described in booklet "Transue & Williams Challenges the Future." 20 pages. Transue & Williams Steel Forging Corp.

Circle 614 on page 19

Cylinder-Finish Tubing

Along with performance and application data on Rockrite cylinder-finish tubing, bulletin R7A explains why the tube reducing process of forming Rockrite results in smooth inside and outside diameter surface and close ID tolerance. 4 pages. Tube Reducing Corp.

Circle 615 on page 19

Electronic Equipment

Six data sheets respectively describe the model ER-1 web edge register detector, model F-2 direct impulse counter, model PW-5 five-selection preset electronic counters, model LF-1A lineal footage counter, model P3-RM decitron electronic

THIS IS GLASS

a bulletin of practical new ideas from Corning

How to get ahead with infrared

Fact: Every object whose temperature is above absolute zero (−273°C.) radiates infrared energy.

Additional fact: Considerable effort has been poured into developing mechanisms for detecting and utilizing infrared.

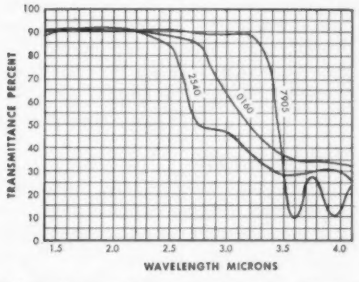
Among the more dramatic have been numerous devices for the military—items used for *target detection*, *missile guidance*, and *mapping*.

These tasks were once the unchallenged province of radar, though infrared is *older*, having been used after World War I in some experimental aircraft spotting. And while radar was the *big* weapon in World War II, the Germans used infrared both to supplement it and to counter Allied chaff.

Since then infrared technology has advanced rapidly. Today it is reported to be *less* expensive, *less* complex, and *more* discriminating than radar for some applications.

Our interest in infrared techniques centers on optical materials and design. Historically, *glass* has been *the* approach to selective handling of varied forms of radiant energy. Today, special glasses still hold the key to such control.

For example, three special Corning glasses are eminently suited to infrared transmission.



Infrared transmitting curves for three Corning glasses are shown for the 1.5 to 4.0 microns range.

Glass 0160, a crystal white form, can be made into flat plates, pressed, or blown. Glass 2540 is opaque red and comes in flat plate *only*.

The third glass is 7905, one of the 96% silica glasses from which VYCOR brand products are made. Along with its infrared talent, this glass has: (a) capacity to operate continuously at high temperatures; (b) exceptional resistance to chemical attack; (c) ability to stand up to thermal shock.

(Note: Other 96% silica glasses share these characteristics but possess different, though equally useful, *optical* properties.)

Suggestion: If infrared maneuvering is one of your "hot" problems, write for details on the three glasses mentioned. Or, if the other diverse talents of the VYCOR group of glasses seem attractive, ask for Bulletin B-91. It provides all the pertinent data, plus facts on applications.

Small fanfare for a BIG development

Lighter than aluminum . . . stronger than tempered plate glass . . . harder than high carbon steel.

More? Electrical properties compare favorably with the best ceramics; coefficient of expansion can be positive, negative, or zero; stays rigid at temperatures that warp steel and melt copper; immune to the corrosive destruction of many chemicals.

What is it? PYROCERAM—the trademark for Corning's new *crystalline materials* made from glass.

Aside from their many remarkable properties PYROCERAM materials offer this important advantage: they can be worked by many *conventional* glass forming processes. To wit:

PYROCERAM, Corning's new crystalline material can be worked by many techniques. Large dish was blown; shallow dish, pressed; tube, drawn; and blade made by investment casting.

First commercial application for these revolutionary new man-made materials is in nose cones for guided missiles. What else? Send us your ideas. Also ask for PYROCERAM Progress Report No. 1. It compares four forms of PYROCERAM with four glasses, three ceramics, and five metals. Other reports will follow.

Easy as pie

Take a pie plate. But make sure it's PYREX brand.

Remove the usual household markings and modify the shape just a bit. *Voilà!* No longer do you have a kitchen utensil. Instead? A *right*-sized, *right*-shaped *window*. For? Ovens, washers, dryers.

This metamorphic approach to component design and procurement offers all the advantages of Corning's long experience in mass production.

For example, the appliance maker who uses the pie-plate-like window gets a reliable, economical supply source—*without* the time and money usually required for development, expansion, and tooling up.

And, he gets a *rugged* window that he can *install* and *sell* with confidence.

The adapting or making something new from an already-existing item is a wide open field at Corning since some 40,000 available products are considered *standard!*

Still, there's no denying that *many* of our most successful ventures have resulted from combining *our know-how* with customer skill and need. Result? *Custom* design and fabrication of many, many components and products.

Want to try your hand? You might start by perusing "This Is Glass," a well illustrated primer. Or outline in a memo to us what's on your mind. At least put these informative brochures in your ready-reference file: B-83 (revised)—"Properties of Selected Commercial Glasses"; IZ-1—"Glass, its increasing importance in product design." One, or all *free*.

Corning means research in Glass

CORNING GLASS WORKS, 52-10 Crystal Street, Corning, N. Y.

Please send me the following material: "This Is Glass" ☐; Bulletin B-91—"Vycor Brand Industrial Glassware" ☐; PYROCERAM Progress Report No. 1 ☐; B-83 (revised)—"Properties of Selected Commercial Glasses" ☐; Infrared Transmitting Glasses ☐; IZ-1—"Glass, its increasing importance in product design" ☐.

Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____

Circle 477 on page 19

counter with a shock mount, and the model P3-RM preset electronic counter. Post Machinery Co.

Circle 616 on page 19

Bearings & Rod Ends

Bulletin 257 lists features and engineering data on Spherco line of spherical bearings and rod ends. Stephens-Adamson Mfg. Co., Sealmaster Bearing Div.

Circle 617 on page 19

Gas & Liquid Valves

Robbins metering valves for either liquid or gas operations are described with complete engineering data in bulletin 6157. Operating pressures for the metering units is 6000 psi, and for instrument valves, 3000 psi. Temperature range is from −100 to 500° F. 8 pages. Robbins Aviation.

Circle 618 on page 19

Gasket Materials

A useful and comprehensive reference book, this plastic-bound brochure covers asbestos, cork, felt, fiber and paper, rubber, and miscellaneous gasket and packing materials. Mechanical packings, boiler gaskets, and tapes are also described. An engineering section is provided. 46 pages. Rhopac Inc.

Circle 619 on page 19

Plastics

Fields of activities of this company in supplying Furane, epoxy, and urethane plastics and products for various industries are outlined in illustrated bulletin. Materials are formulated for specific properties. 4 pages. Furane Plastics Inc.

Circle 620 on page 19

Relay Terminology

Relay terms as defined by the National Association of Relay Manufacturers are listed alphabetically in bulletin No. 1884. Clear definitions are included. 20 pages. Automatic Electric Co.

Circle 621 on page 19

Mica

Properties of natural mica, tips on parts design to use various properties, and engineering data comprise illustrated "Mica Bulletin." High dielectric strength and 1000° F thermal resistance are highlighted. 6 pages. Ford Radio & Mica Corp.

Circle 622 on page 19

Malleable Iron Castings

"Value analysis" is applied to malleable iron castings in brochure WRP. Casting characteristics covered are machinability, cold forming, impact resistance, corrosion resistance, versatility of castings, and sizes. Included are specifications for standard and pearlitic malleable iron. 8 pages. Malleable Founders' Society.

Circle 623 on page 19

Self-Locking Bolts

Principle of operation, engineering standards and tightening information relative to Place self-locking bolts are provided in catalog section. Bolts solve critical problems of fatigue and involuntary loosening. 8 pages. National Machine Products Co.

Circle 624 on page 19

Bevel Gears

"Selection and Rating of Bevel Gears" is title of symposium paper presented by company gear engineer, copies of which are available. Paper discusses the straight bevel, spiral bevel, Zerol bevel and the hypoid gears. Eight charts and 17 design photos are included. 17 pages. Gleason Works.

Circle 625 on page 19

Clutches & Brakes

Described in bulletin MF-1 are Dyna-torQ friction-magnetic clutches and brakes which feature fast operation, self-adjustment, smooth easily-controlled engagement, and high efficiency. Capacities range to 700 lb-ft maximum static torque. 8 pages. Eaton Mfg. Co., Dynamatic Div.

Circle 626 on page 19

Air Cylinders

Noncushioned air cylinders with bores from 3 to 8 in. are subject of illustrated data sheet which lists standard dimensions. Capsule gland construction gives choice of piston rod sizes. 2 pages. Densmore Engineering Co.

Circle 627 on page 19

Drive & Control Shaft

Specifications, design, and applications of Clark Flexible Link shaft for power drive and remote control purposes are covered in bulletin "Long Arm for Industry." Speed up to 1800 rpm can be transmitted. 6 pages. Clark Flexible Link Shaft Co.

Circle 628 on page 19

Hex Head Cap Screws

Offered in stock sizes of ¼ to 1-in. diameter, with fine or coarse threads, line of hexagon head cap screws is made self-locking and vibrationproof by use of the Nylok nylon pellet in the threaded portion. Pellet also seals against fluid leaks. Bulletin gives complete data. 4 pages. Cleveland Cap Screw Co.

Circle 629 on page 19

Clamps & Fasteners

Design and application details of a complete line of clamps and fasteners for aircraft, container, and closure applications are contained in illustrated catalog. Featured is Gearlock clamp line which gives air- and water-tight container seals. 16 pages. Bassick Co.

Circle 630 on page 19

Instruments & Controls

"Technical Notes" is title of bimonthly publication dealing with instruments, controls, aircraft components, and electronic devices. Sections are devoted to technical articles, engineering book reviews, reference data, and new products. Qualified designers will be placed on the mailing list. 4 pages. G. M. Giannini & Co.

Circle 631 on page 19

Photo-Etched Parts

Photo-formed parts, etched to close tolerances and often in intricate patterns, are described in bulletin 90. Typical parts include filters, strainers, dials, cams, linkages, gears, and diaphragms made of any metal that can be etched. Design potentials are covered. Superior Tube Co.

Circle 632 on page 19

Timing Motors

Permanent magnet and hysteresis type, high torque, synchronous timing motors with output speeds from 1/60 to 16 rpm for use on 115 and 230-v 60-cycle ac are described in bulletin 100. 4 pages. E. Ingraham Co.

Circle 633 on page 19

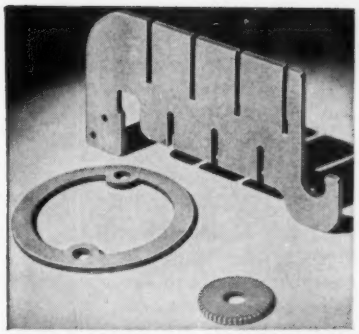
Edge-Lighted Panels

Resistance to abrasion, cleaners, and solvents; flush letters; availability in colors; low cost; and matte or glossy finish are features of E-Bond edge-lighted panels which are subject of question-and-answer bulletin. 7 pages. Kerrco Products.

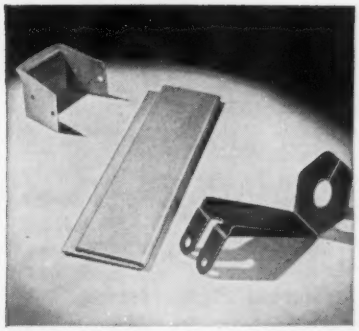
Circle 634 on page 19

Hydraulic Equipment

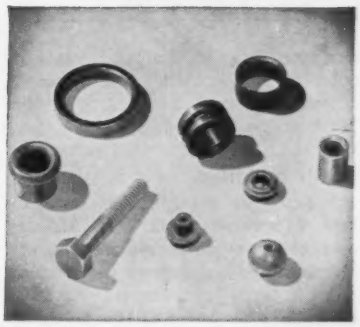
Valves, cylinders, pump units, presses, and special control systems are typical of industrial hydraulic equipment made by this company for 1000 to 3000-psi service and described in bulletin BL-757. Produc-



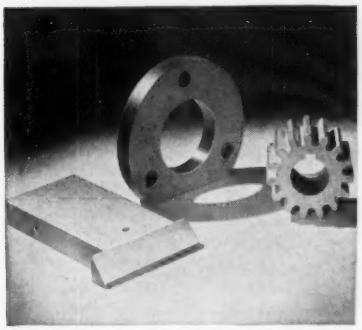
LEFT: Sheet stock; shear strips and punch. **TOP:** Sheet stock; shear strips, punch blank, gang-saw notches. **BOTTOM:** Sheet stock; shear strips, punch blank, mill notches.



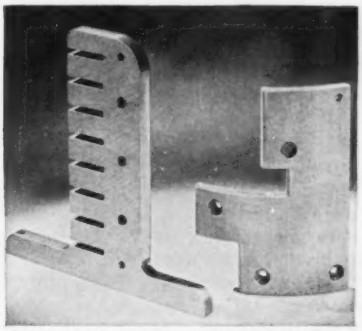
TOP LEFT: Sheet stock; shear strips, punch, form. **CENTER:** Sheet stock; shear to size, drill, form. **BOTTOM RIGHT:** Sheet stock; shear strips, punch pieces, form twice in mold, rubber-stamp twice.



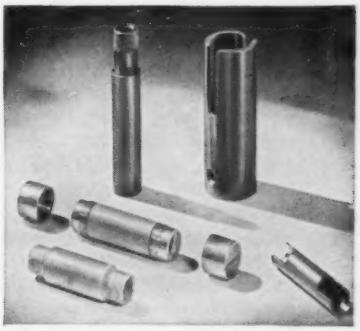
LOWER LEFT: Hexagonal rod; smooth-saw, automatic screw machine, turn shoulder thread, chamfer, and cut off. The other samples are automatic-screw-machine parts made from Diamond Fibre by C-D-F.



LEFT: Sheet stock; sand, smooth-saw to size, smooth-saw bevel, smooth-saw corner cut-out, drill. **CENTER:** Sheet stock; band-saw, turn OD, bore ID, smooth-saw side, drill five blind holes with jig. **RIGHT:** Sheet stock; sand, band-saw, rough-bore ID, hob teeth, finish-bore ID, machine keyway.



LEFT: Sheet stock; sand, smooth-saw, drill, smooth-saw to shape, radius three corners, gang-saw notches. **RIGHT:** Sheet stock; band-saw rough blanks; form; smooth-saw width, length, and shape; radius edges; drill with jig; countersink.



LOWER LEFT: Tube stock; automatic screw machine, turn shoulders, chamfer and thread end, thread other end. **UPPER LEFT:** Tube (two diameters); smooth-saw, tap, screw-machine larger piece; screw-machine, thread, knurl, chamfer, cut off small piece. **UPPER RIGHT:** Tube; smooth-saw to length, punch twice, countersink. **LOWER RIGHT:** Tube; screw-machine, chamfer, cut off, punch.

C-D-F fabricates and forms DIAMOND VULCANIZED FIBRE

FAST . . . AT LOW COST . . . DEPENDABLY

Vulcanized Fibre is a wonderful material if you know where to use it and how to buy it. We suggest on many jobs that it's best to do the fabrication and forming in C-D-F's shops. Why? Because C-D-F knows how. Since 1895 the company has put fibre to work in everything from buggy axle bushings to metal clad radio parts. The handling of thousands of set-ups for high speed, low cost production runs gives C-D-F an "experience bank" to draw from. Shop supervisors have a wealth of short cuts, little tricks that result in lower prices for you. They know the material and its peculiarities.

TOUGH, RESILIENT, STRONG

How long has it been since you examined the unique properties and wide range of C-D-F fibre grades? Vulcanized Fibre is arc resistant, mechanically strong, non-corroding, half the weight of aluminum. Repeated moistening and drying in forming insignificantly alters the nature, structure or quality of the fibre.

Since C-D-F has their own paper mill, uniform, quality control is made possible. Special grades are more easily developed. A good example is C-D-F Abrasive Fibre, a medium density fibre with excellent resin and grit adhesion, now widely used for abrasive discs.

A BIG, RELIABLE SOURCE

C-D-F does business with the largest tonnage users of sheet, rod and tube fibre in the world. This means good deliveries, good prices, reliable products for every new customer. You deal with a materials engineer, a C-D-F man who knows how to give you the most value in Diamond Vulcanized Fibre. If you want to improve design, simplify purchasing, speed production, use Diamond Fibre and the facilities of C-D-F. Write for catalog, free test samples, or send us your print for quotation.

CDF **CONTINENTAL-DIAMOND FIBRE**

A SUBSIDIARY OF THE Burkl COMPANY • NEWARK 23, DELAWARE

Circle 478 on page 19

tion facilities of company are outlined. 12 pages. Benjamin Lassman & Son.

Circle 635 on page 19

Metal Moldings

Designs and specifications on moldings fabricated from stainless and cold rolled steel, brass, bronze, and aluminum are contained in full-color catalog. 78 pages. Serrick Corp., John Lees Div.

Circle 636 on page 19

Steel Bars

Handy 11 x 17-in. wall chart shows all AISI grades of cold finished steel bars in round, hexagon, and square shapes up to 6 in. in cross-section. Machinability ratings, chemical analysis, and other data are listed for 241 grades. LaSalle Steel Co.

Circle 637 on page 19

Aviation Parts

File folder contains brief descriptions of hinges, connectors, spars, stringers, doublers, and other allied products engineered and manufactured for the aviation industry. Facilities of company are discussed. 9 data sheets. Moynahan Bronze Co.

Circle 638 on page 19

Photoelectric Controls

Over 1000 different uses of Cats Eye slit type optical system for photoelectric controls are listed in illustrated bulletin. This sensitive, high speed control supplies the needs of modern automation. Mason Instrument Co.

Circle 639 on page 19

Thin Metal Strip

Product directory No. 1 gives complete design data on Pennrold thin strip rolled to exacting standards. Properties of beryllium copper, chromium copper, phosphor bronze, nickel silver, brass, copper, stainless, and nickel iron strip are listed. 12 pages. Penn Precision Products, Inc.

Circle 640 on page 19

Speed Reducers

Selection information on Series ST torque arm and Series SF flange-mounted worm gear speed reducers of shaft-mounted type are contained in illustrated catalog SM-57. 8 pages. Winsmith, Inc.

Circle 641 on page 19

Welding Studs

Information required to obtain optimum results, at lowest cost, in detailing and specifying Nelson standard end-welding studs is covered in data book "Stud Specifications." Dimensions, mechanical properties, and other data are presented on studs and ferrules. 38 pages. Gregory Industries, Inc., Nelson Stud Welding Div.

Circle 642 on page 19

Reinforced Plastic Tubing

Bardex polyvinyl tubing in diameters from ⅛ to 1 in. is metal reinforced. In addition to withstanding acids, alkalies, petroleum products, and repeated bending, it is self-extinguishing. It is particularly usable as electrical conduit. Full information is given in leaflet. 1 page. Newage Industries, Inc.

Circle 643 on page 19

Cylinders & Controls

Condensed information on a complete line of air and hydraulic cylinders and valves are presented in folder "The Complete Line." Also detailed are power units to supply 0.4 to 80 gpm of hydraulic fluid at pressures to 1500 psi. 4 pages. Rivett, Inc.

Circle 644 on page 19

Electric Control Systems

Design, engineering, and manufacturing facilities of this company which are available to produce custom-built electric control systems are outlined in illustrated bulletin. Capsule descriptions cover controls for cranes, processes, materials handling, and automation. 4 pages. Rundel Electric Co.

Circle 645 on page 19

Instrument Parts

Custom-made instrument parts and assemblies are produced by this company. Outline of what can be produced is included in folder, along with photos of typical parts. 4 pages. R. S. Wilder, Inc.

Circle 646 on page 19

Paper Tape Equipment

Paper tape winder and unwinder equipment, accessories for data processing, business machines, comparators, electronic computers, and other equipment are subjects of illustrated folder. 4 pages. Whiteford Laboratory.

Circle 647 on page 19

Magnetic Starters

NEMA size 0 and 1 magnetic motor starters for machine tools, pumps, hoists, saws, fans, and other equipment are described in illustrated bulletin GEA-6611. How design contributes to fast installation, easy inspection and maintenance, and flexibility is related. 20 pages. General Electric Co.

Circle 648 on page 19

Research & Development

"From Raw Materials to Complete Systems" is title of brochure which highlights company activities in materials research, component development, data instrumentation, ultrasonics and acoustics, medical instrumentation, and nuclear research. 8 pages. Gulton Industries, Inc.

Circle 649 on page 19

Hose Fittings

Made from solid brass bar stock, line of air and water hose fittings covered in illustrated folder includes pipe elbows, nipples, hex bushings, ferrules, and clamps. Elbows and shapes are formed by silver soldering components together. 4 pages. Service Mfg. & Supply Co.

Circle 650 on page 19

Engineering Services

Such services as machine design and fabrication, equipment layout, equipment and material procurement and installation, personnel training, and engineering consultation are offered by this company. Several case histories are included in brochure. 12 pages. Teller Co.

Circle 651 on page 19

Brakes

Series of power, hydraulic, and mechanical brakes for vehicle applications is subject of illustrated catalogs. Design features and specifications are given for units for on- and off-highway, power shovel, crane, and other uses. Rockwell Spring & Axle Co., Timken-Detroit Brake Div.

Circle 652 on page 19

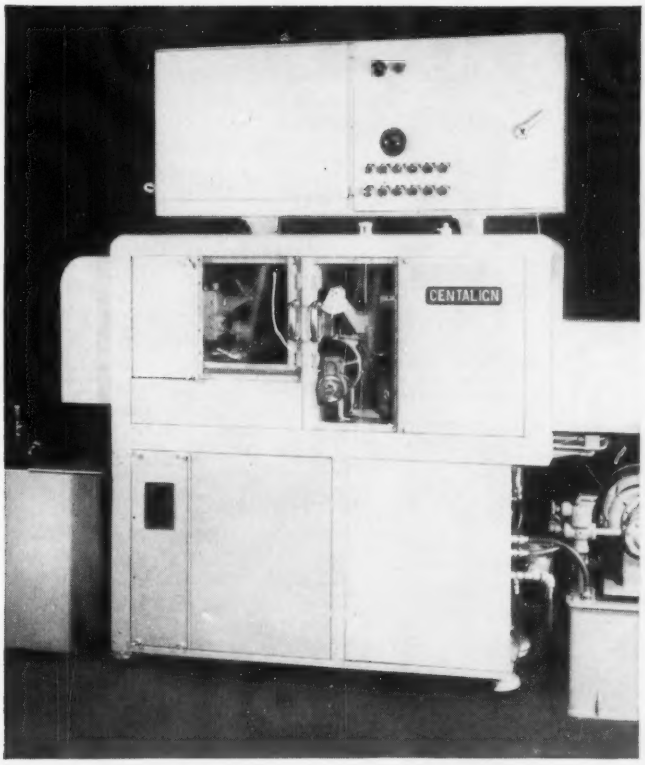
Panel Meters

Dimensional details and performance specifications of Waters line of D'Arsonval type ammeters, millivoltmeters, and voltmeters, as well as alternating current rectifier type microammeters, milliammeters, and voltmeters are found in catalog 5002. 16 pages. Waters Mfg., Inc.

Circle 653 on page 19

Heat Exchanger Tubing

"Design and Cost Comparison of Heat Exchangers Using Wolverine Trufin" is illustrated brochure for engineers, estimators, and designers.



Bryant "Centalign" internal grinder for finishing tapered bearing races. Built for lower cost with welded steel.

LESS WEIGHT... GREATER CAPACITY

Costs cut with welded steel

By taking full advantage of the superior strength and rigidity of steel, engineers of the Bryant Chucking Grinder Company have reduced the cost of this machine base.

Other significant benefits are:

- **Reduced Weight**—26% less.
- **Increased Capacity**—swing of machine increased from 9 to 12 inches.
- **Closer Tolerances**—average size variations from piece to piece on bearing races lowered from 0.00040 to 0.00015 inches and surface finish improved from 21 to 10 microinches rms.

These advantages are typical of those being realized by machine tool manufacturers who have designed their product for welded steel. You can attain similar benefits. The Lincoln Electric Company stands ready to assist with your redesign projects.

DESIGN HELPS for engineers and designers

"Procedure Handbook of Arc Welding Design and Practice" new 11th edition, 1300 pages, over 1100 illustrations. Has 240 page section on Machine Design. Price only $3.00 postpaid in U.S.A. $3.50 elsewhere.

Machine Design Seminars conducted regularly at our plant in Cleveland.

Machine Design Sheets sent free to designers and management.

Write to us for full details.

LINCOLN

THE LINCOLN ELECTRIC COMPANY

Dept. 1125, Cleveland 17, Ohio

The World's Largest Manufacturer of Arc Welding Equipment

When welded steel is three times stronger than iron

Has 2½ times the rigidity

Yet costs ⅓ as much per pound

WHY use anything but welded steel for machine bases?

Circle 479 on page 19

Helpful Literature

It provides an analysis of plain condenser tube and Trufin sheet and tube exchanger costs. 20 pages. Calumet & Hecla, Inc., Wolverine Tube Div.

Circle 654 on page 19

Stainless Fasteners

Thirty-seven different types of standard stainless steel fasteners are illustrated in condensed fastener guide. Included are screws, nuts, bolts, washers, rivets, and AN fasteners. Size, thread, head and point style, and stainless grade data are included. 8 pages. Allmetal Screw Products Co.

Circle 655 on page 19

Meter-Relays

Automatic control with miniaturized nonindicating meter-relays is described in illustrated bulletin 104A. Complete circuitry information is included. Very high sensitivity and plug-in models are covered. 12 pages. Assembly Products, Inc., San Gorcinto Div.

Circle 656 on page 19

Superpressure Equipment

Standard and accessory high pressure items, plus custom-built superpressure equipment, for use up to 100,000 psi and 1000° F are detailed in catalog 407. Covered are reaction vessels, valves, tubing and fittings, hydraulic and gas booster pumps, compressors, pressure generators, pressure balances, and dead weight gages. 125 pages. American Instrument Co.

Circle 657 on page 19

Stainless Castings

Types and applications of stainless steel sand castings produced by this company are shown in brochure. Specifications of common stainless steel alloys are given. 4 pages. Alloy Steel Casting Co.

Circle 658 on page 19

Linear Accelerometers

Line of linear accelerometers for direct recording of maneuvering or low frequency accelerations of various moving vehicles is subject of illustrated data sheet. Specifications of low and medium frequency models are included. 2 pages. B & F Instruments, Inc.

Circle 659 on page 19

Testing Services

Plant and equipment facilities for environmental, qualification, design evaluation, and production sampling

Machining spur gears made from Bethlehem forged-and-rolled blanks.

When the Blank is Sound, Machining Costs Go Down

You probably know a machinist whose specialty is gears. Some day ask him what a sound blank means in terms of machining speed. Ask him how a sound blank reduces costs.

Directly or indirectly, his answers will tell you why Bethlehem gear blanks are so widely specified. Wherever these sturdy Bethlehem products are used, their advantages are instantly apparent. Made in a two-way mill that both forges and rolls the steel, they are highly uniform and very strong throughout. Internal structure is excellent. There are no hidden pitfalls beneath the surface to snag the cutting tool, delay the work, or cause rejects. These circular blanks can be turned, bored, faced, and hobbed with complete assurance of a good finished job in every respect.

You can obtain Bethlehem forged-and-rolled blanks in sizes from 10 to 46 in. OD, heat-treated or untreated. They are available in a wide range of sections. Use them not only for gears, but for crane and sheave wheels, flywheels, turbine rotors, brake and clutch drums, pipe flanges, etc. Many details are covered in Booklet 216, a copy of which will be mailed at your request.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor, Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Circle 481 on page 19

Helpful Literature

tests; research and development; inspection methods and procedures; and quality control analysis are described in illustrated brochure. Tests cover avionic, electronic, mechanical, pneumatic, and hydraulic equipment. 12 pages. Aerotest Laboratories Inc.

Circle 660 on page 19

Flow Meters

Interchangeable, predictable performance metering floats are incorporated in Full-View Rotameters, subject of illustrated bulletin 115. Floats can be used for common flow indications or in remote pneumatic or electric transmission or alarm functions. 12 pages. Brooks Rotameter Co.

Circle 661 on page 19

Clutches

Methods of actuating Precision-spring overrunning clutches are detailed in illustrated bulletin PSC-100. Advantages of this type of clutch and typical installations are covered. 8 pages. Curtiss-Wright Corp., Marquette Div.

Circle 662 on page 19

Printed Chart Materials

Tape-Pen tool designed to facilitate application of 1/32 and 1/16-in. widths of Curve Line tape is described in catalog of pressure-sensitive printed tapes, templates, workboards, and other chart materials. 24 pages. Chart-Pak, Inc.

Circle 663 on page 19

Shaded-Pole Motors

Detailed drawings, technical data, and other information on shaded-pole motors for small fans, electronic equipment, power tools and other uses are found in illustrated bulletin. The 402 Long Life series with camel bearing and 401 Standard Life series are covered. 4 pages. Controls Co. of America.

Circle 664 on page 19

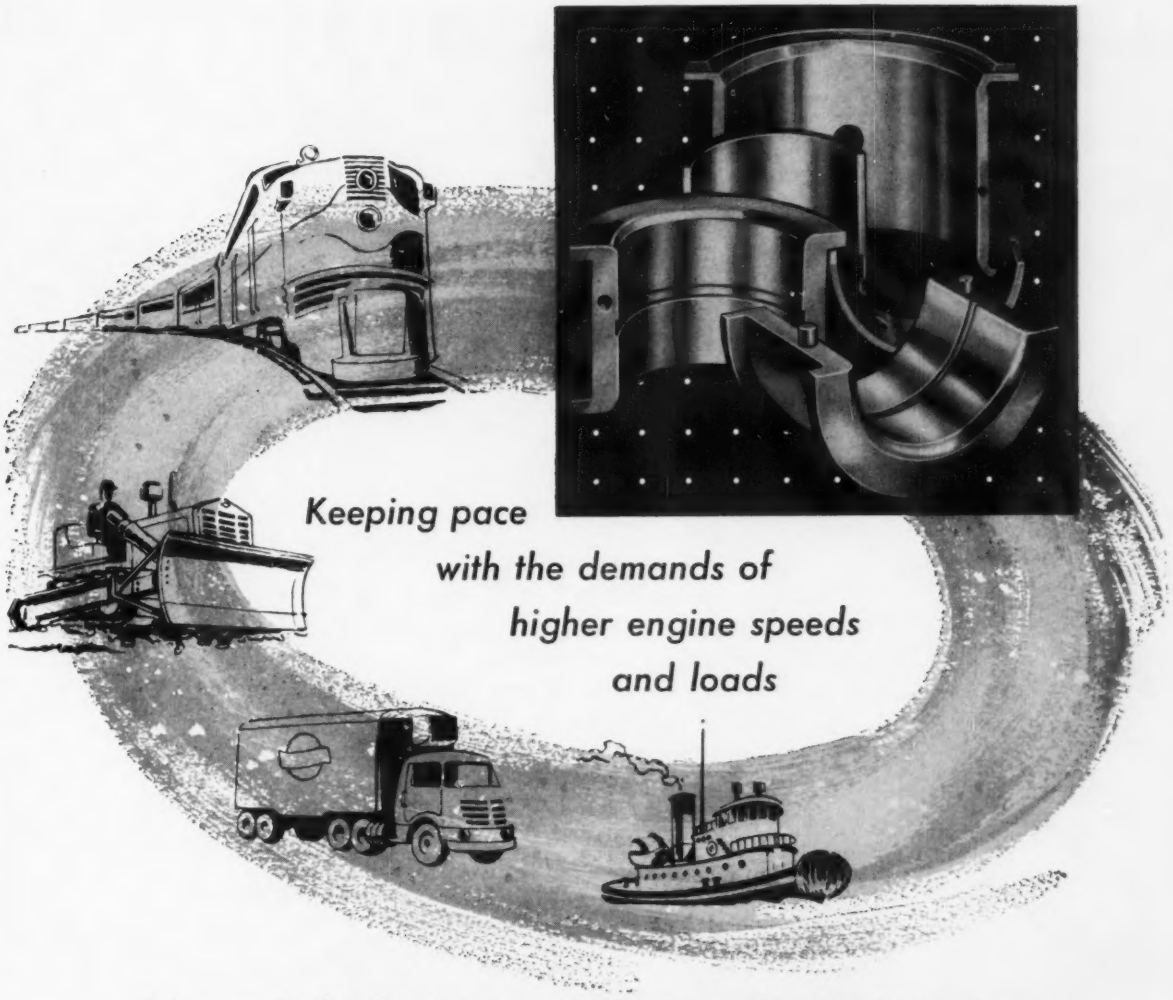
Power Supply

A 60-w switching transistor power supply, regulated against both line and load variations simultaneously, is subject of folder S-2-37. It is used as a lightweight replacement for rotating equipment having 150 and 300 v dc outputs. 4 pages. Arnold Magnetics Corp.

Circle 665 on page 19

Coiled Cords

Characteristics and uses of communication and power coiled cords are described in illustrated bulletin.



Johnson Solid Aluminum and Aluminum-On-Steel Bearings

For better performance, and to meet the demands of engine manufacturers, Johnson Bronze pioneered the development of solid aluminum and aluminum-on-steel bearings.

Solid aluminum bearings carry loads up to 4000 psi, and aluminum-on-steel to 6000 psi. These bearings have excellent embeddability properties, are ductile enough to conform to slight misalignments, and have high resistance to acid formation and attack by additive oils.

Johnson aluminum bearings are available in a wide range of plain or flanged, full or half bearings, with or without precision overlay. Take advantage of our years of experience in aluminum bearing design and production—your Johnson representative will be glad to work with you in improving the performance of your engines.

Johnson Bronze

525 South Mill Street • New Castle, Pa.

JOHNSON Bearings

POWDER METALLURGY—BRONZE OR IRON | ALUMINUM ON STEEL SOLID ALUMINUM | BRONZE ON STEEL | STEEL AND BABBITT | GRAPHITED BRONZE | BRONZE—CAST OR ROLLED

Circle 484 on page 19

Helpful Literature

Wire types, constructions, terminations that can be used, and outline drawings of various types are included, along with engineering data. 16 pages. Essex Wire Corp., Cords Limited Div.

Circle 666 on page 19

Structural Steels

Characteristics of and uses for super-strength structural steels with minimum yield strengths from 55,000 to 150,000 psi are described in technical booklet. Fifteen grades of steel produced by seven companies are reviewed. Tables describing their composition, mechanical properties, heat treatment, corrosion resistance, machinability, size limitations, and end uses are included. 20 pages. Climax Molybdenum Co.

Circle 667 on page 19

Engineering Services

"Meet Associated Engineers, Inc." is title of brochure which outlines the complete engineering service to manufacturers offered by this company. It covers mechanical and tool engineering divisions, industrial laboratory, special services, and special products divisions. 8 pages. Write to Associated Engineers, Inc., 349 Silver St., Agawam, Mass.

Electronic Controls

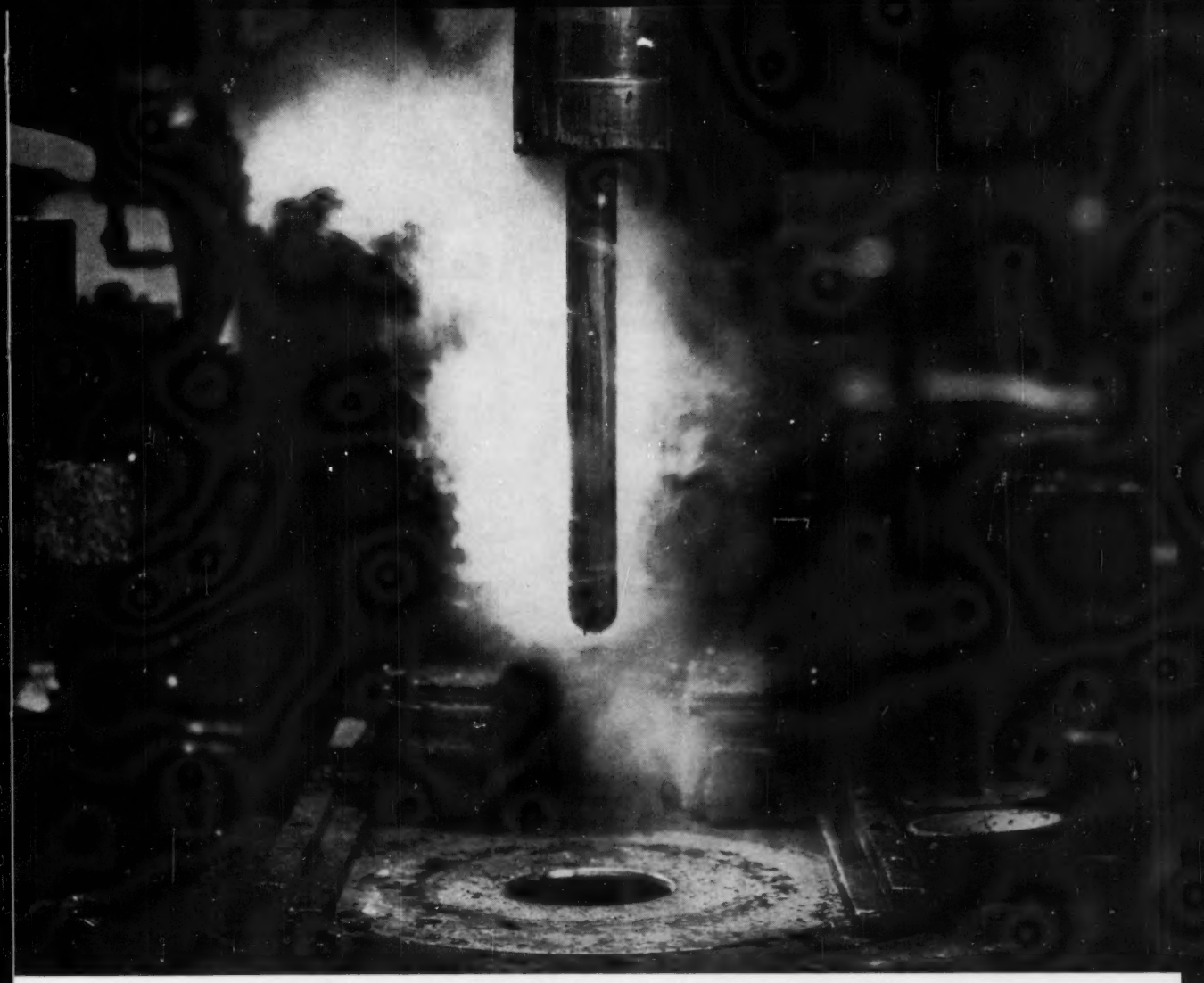
Entire line of Keithley instruments for electronic control and measurement is covered in descriptive catalog B. Vacuum tube voltmeters, electrometers, meg-megohmmeters, micro-microammeters, and amplifiers for industrial and laboratory use are described. 24 pages. Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, Ohio.

Low Voltage Relays

Service bulletin RT-100 gives engineering specifications on Remcon low-voltage relays which feature their own built-in transformers. Relays are rated 15 amp, 1/3 hp and have fine silver contacts. 2 pages. Write Pyramid Instrument Corp., 630 Merrick Rd., Lynbrook, N. Y.

Socket Head Cap Screws

"Guide for Design and Assembly of Mac-it Head Cap Screws" is packed with torque-tension data on all standard sizes of Mac-it socket head cap screws. Physical characteristics, specifications, dimensions, thread lengths and standard stock sizes are also given. 8 pages. Strong, Carlisle & Hammond, Mac-it Screw Div., 1392 W. 3rd St., Cleveland 3, Ohio.



Tough 2½" diameter mandrel at Rc 44 on 1150 ton brass extrusion press. Scovill Manufacturing Co.

Mandrel of HALCOMB 218 retains toughness and hardness at hot work temperatures...

This mandrel is made of Halcomb 218—a tough, air-hardening hot work steel. Halcomb 218 is suitable for tools like this which require a higher degree of toughness at moderately elevated temperatures than is obtainable with the tungsten types of hot work steels. And Halcomb 218 *retains both* its hardness and strength at these temperatures.

For example, at a hardness of Rc 44, Halcomb 218's Charpy Impact Strength is 33 ft-lbs at 500F. And it will retain this hardness after 1 hour, after 10 hours and even after 100 hours at temperatures up to 900F.

Properties like these cut tooling costs. The mandrel shown above is good for 1200 pushes, for example, and even then all it needs, usually, is repolishing before being used again.

Halcomb 218 is particularly useful for all hot work operations on which drastic coolants are used. It even resists breaking very successfully when water cooled in operation. If these sound like advantages you can use, call your local Crucible representative for more complete data. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor—Railway & Power Engineering Corp., Ltd.

Circle 486 on page 19

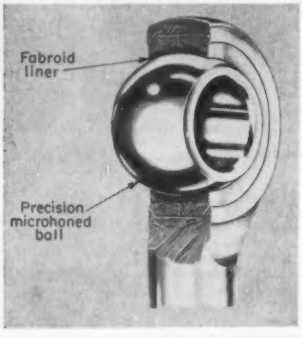
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Self-Lubricating Bearing

supports static loads to 60,000 psi

Fabroid bearing is a composite structure consisting of two fused layers bonded and cured at elevated pressures and temperatures. Dense lattice of Teflon fibers facing bearing surface is supported by interlinked glass-phenolic structure. Under load, contact between two bearing surfaces causes strands of Teflon to interlock, preventing Teflon from extruding and permitting the support of static loads to 60,000 psi. When Fabroid



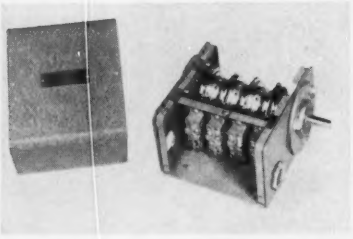
liner is used in self-aligning bearings or rod ends, coefficient of friction does not exceed 0.04 in temperature range from −65 to 400 F. Bearings do not gall or seize if subjected to overloads or contaminated atmospheres. **Micromatic Hone Corp.**, Micro-Precision Div., 2205 Lee St., Evanston, Ill.

Circle 668 on page 19

Limit Switch

is rotating-cam unit with split-type lobes

Independently adjusting split-type lobes, ball bearings, and reversible shaft are incorporated in this rotating-cam limit switch. Each



lobe is locked in place by a positive screw wedging action. Turning a screw unlocks one lobe and permits adjusting screw to rotate lobe with respect to mating lobe, which is still locked in place. By adjusting one lobe with respect to the other, a continuous open or closed-circuit range can be obtained from 360 down to 3 deg, without changing cam lobes. Switches are available in NEMA types 1, 4, 7, and 12 enclosures with two to twelve circuits. **Gemco Electric Co.**, 25685 W. Eight Mile Rd., Detroit 40, Mich.

Circle 669 on page 19

Flexible Gear Belt

provides positive traction on small diameter pulleys

Thin, lightweight transmission belt is of endless construction and has small, precision-molded teeth which mesh with corresponding teeth on pulleys. Belts assure a constant relationship between two or more shafts, eliminating the possibility

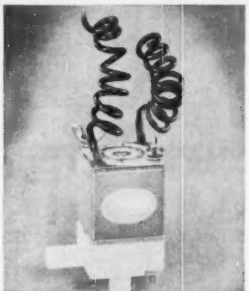
of pulley slippage. Belts, which have high shear strength, are useful with sound and data recorders, instrumentation, control knobs, and high-speed grinders requiring high-speed step-up or maximum traction. They are available with 40 and 120 DP teeth. **Russell Mfg. Co.**, 385 E. Main St., Middletown, Conn.

Circle 670 on page 19

Solenoid Valve

is all-plastic unit

SV-5100 plastic solenoid valve is a compact, lightweight unit that handles caustics, acids, and highly corrosive media. There is no metal contact with media being handled. Bubbletight seal provides long life under extreme conditions. No fit-



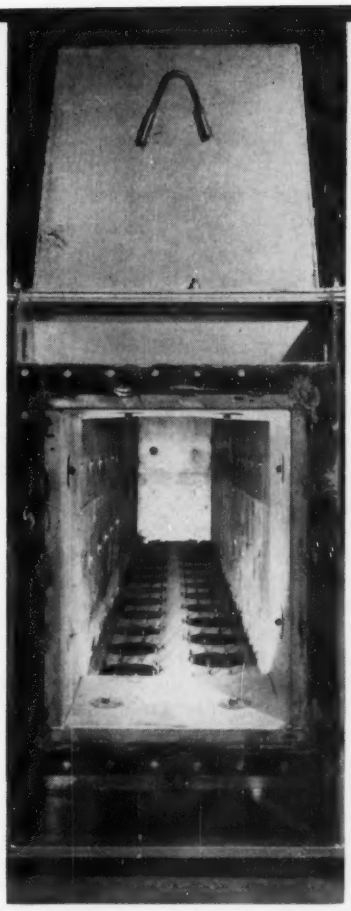
tings are required, and valve operates in any position. Unit operates on 115 v 60 cycles ac. **Valcor Engineering Corp.**, Carnegie Ave., Kenilworth, N. J.

Circle 671 on page 19

Spring-Steel Fastener

for shaft-retention applications

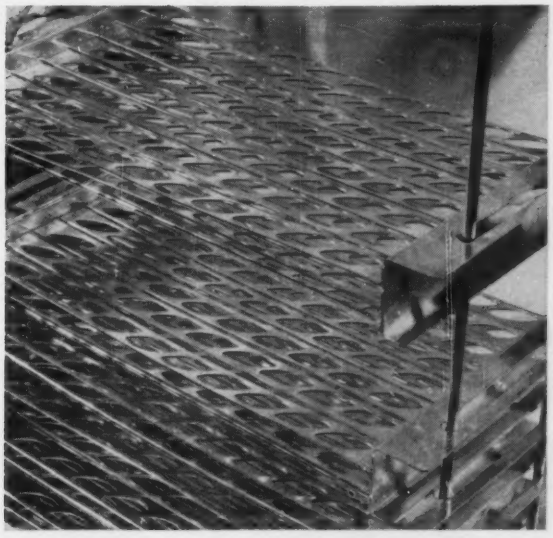
Special pilot teeth which guide the fastener onto the shaft are incorporated in a line of spring-steel fasteners for shaft-retention ap-



NOTHING can equal Stainless Steel

in its unique combination of properties

No other design material can match Stainless Steel in its combination of desirable properties: corrosion resistance, strength, hardness, beauty, cleanability and easy fabrication. For a reliable source of supply, United States Steel offers you the widest range of types, finishes and sizes. **Just call your steel warehouse.**



For High Temperatures. This recuperator is used on industrial furnaces. It uses waste flue gas to heat the incoming furnace air and thereby increase the efficiency of the furnace. Formerly, these recuperators were made with ceramic tubes, but heat transfer was low and leakage was high. The Hazen Engineering Company in Pittsburgh makes recuperators almost completely from Stainless Steel. Compared to ceramic designs, the Stainless design saves about 40% in fuel, increases furnace output about 10%-15%. The Stainless Steel performs well, even at this 1800-2300° F. temperature range.

For Cleanliness. When you work near nuclear radiation areas, you wear a small badge containing X-ray film that records how much radiation you have received. The film, "photodosimetric film," is developed in a Sensitometric Processing Unit made by Bar-Ray Products, Inc., in Brooklyn. The unit, including the trays shown here, is made completely from 18-gage Type 316 Stainless Steel because it resists corrosion, is easy to clean, has a hard, dense surface that doesn't harbor dirt.

United States Steel Corporation, Pittsburgh • American Steel & Wire Division, Cleveland
Columbia-Geneva Steel Division, San Francisco • National Tube Division, Pittsburgh
Tennessee Coal & Iron Division, Fairfield, Ala.
United States Steel Supply Division, Warehouse Distributors
United States Steel Export Company, New York

For Corrosion Resistance. The Hercules Powder Company needed an ammonium nitrate storage tank for their plant near Richmond, California. They took an old, World War I concrete reservoir and lined it with Type 304 USS Stainless Steel. The 14-gage sheets are laced with 18,000 feet of vacuum-tested welds. Tank holds two **million** gallons of solution, and is 200 feet in diameter at the top. U. S. Steel's Consolidated Western Division handled the complete installation.

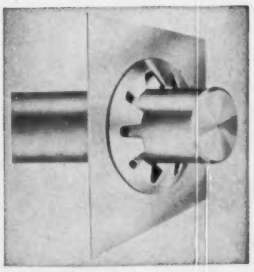
USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

Circle 487 on page 19

New Parts



plications. Designated Springrips, the high carbon steel fasteners slip over metal or plastic shafts, studs or rods and lock in place with strong spring tension. Fastener is cone shaped, and has an internal diameter slightly smaller than shaft. Spring-steel teeth resist movement in an opposite direction by engaging the shaft around its full circumference. Fastener is available in a full range of sizes. **Illinois Tool Works,** Fastex Div., 195 Algonquin Rd., Des Plaines, Ill.

Circle 672 on page 19

Gear Assemblies

antibacklash units are of aluminum or stainless steel

Antibacklash gear assemblies for ⅛, 3/16, and ¼-in. shafts are available in set screw and clamp-type hub. AGMA Precision I and

II gear teeth and pitches are available in both aluminum and stainless steel. **PIC Design Corp.,** 477 Atlantic Ave., East Rockaway, N. Y.

Circle 673 on page 19

Adjustable-Speed Motor

is footless unit for heavy industrial duty

Compact, footless Varidrive, designated Type VEV, features quick, accurate alignment to driven equipment. Motor, with NEMA style C

Circle 488 on page 19

Circle 489 on page 19→

DOW CORNING CORPORATION

Silicone News

FOR DESIGN ENGINEERS No. 43

New Silicone-Teflon Tape Withstands Acids, Cuts Packaging Costs

A new pressure-sensitive tape with exceptional chemical and thermal stability is now available from Minnesota Mining. Made from "Teflon" coated with a Dow Corning silicone adhesive, the tape readily withstands corrosive chemicals that deteriorate ordinary tapes.

Cap liners die-cut from this new type "Scotch" brand tape have already enabled Merck & Co., Inc., to greatly simplify their method of sealing bottles containing trichloroacetic acid. The acid is so corrosive that the bottles formerly were closed with ground glass stoppers held in place by paper caps fastened down with string and adhesive.

By employing the new silicone adhesive-coated tape, Merck packaging men have found it practical to use ordinary screw-on bottle tops. Small die-cut sections of the tape fitted inside the caps prevent

(*Cont. Pg. 2*)

SILICONE RUBBER ASSURES RELIABILITY OF ELECTRONIC "PACKAGES" ON B-58

In reaching for new plateaus of performance and reliability, designers are getting an assist from Silastic*, the Dow Corning silicone rubber. Typical is the extensive use of Silastic to insulate and protect the delicate electronic "packages" in the fire control system on Convair's B-58 Hustler.

In developing the "packages," heat was a major problem encountered by the designers—the Electronics and Avionics Division of Emerson Electric Manufacturing Company. Certain rubber parts touch miniature tubes that operate at 350 F. Other rubber components, such as seals, cable grommets and clamps, are totally enclosed in packages where even the "cooling" air gets hot. Extreme cold is another problem. When the fire control system is shut off during high altitude flight, temperatures may drop to 65 below zero.

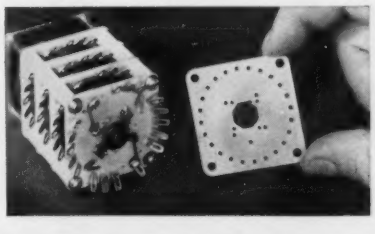
But Silastic easily withstands both extremes of temperature and physical punishment. It stays rubbery from —130 to 500 F, has excellent dielectric strength, moisture resistance and long life. That's why Emerson specified Silastic, and that's why more and more engineers are specifying Silastic for maximum serviceability and minimum maintenance cost in applications ranging from aircraft seals to industrial heaters, from traction motors to home appliances.

*T.M. REG. U.S. PAT. OFF. *No. 436*

New Rotary Switches More Reliable With Silicone-Glass Laminates

Combining unique dielectric and physical properties, silicone-glass laminates can be used to improve the performance of electrical and electronic devices involving extreme heat or moisture. An unusually good illustration is provided by Shallcross Manufacturing Company, Collingdale, Pennsylvania.

Shallcross' new line of 24-position electrical rotary switches features decks stamped from glass cloth laminate bonded with a Dow Corning silicone resin. The heat-stable silicone-glass decks keep terminals locked securely in place despite heat of soldering. More important, the silicone-glass construction of these 1500 V, 1 to 6 deck rotary switches assures reliable operation in hot, cold or humid climates where other insulating materials would fail. (*Cont. Pg. 2*)



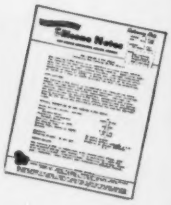
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



Pressure-sensitive silicone tapes—that stick to wet or dry surfaces; form good bonds; have high dielectric strength; repel moisture; are not affected by corrosive chemicals—are described in a new folder designed to help you choose the tape best suited to your application. *No. 440*

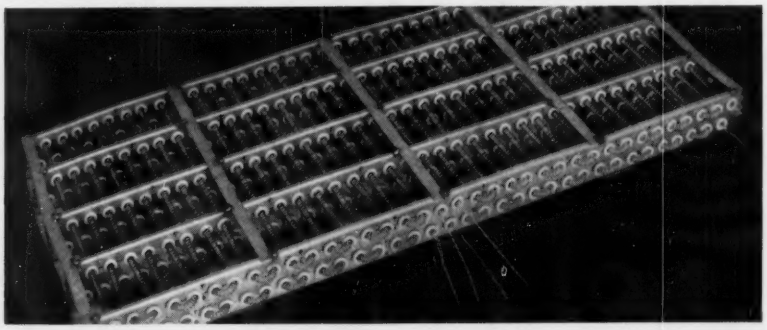
Twelve page, fact-filled reference to Dow Corning Silicones describes the silicone products of interest to most industries. Containing useful data and information, this Guide to Silicone Products is designed expressly to help you enjoy the advantages, profits, and savings made possible through imaginative use of these versatile engineering materials. *No. 441*

Silastic — in mechanical applications — increases life and serviceability of original equipment; reduces maintenance and downtime. A completely new brochure gives properties and cites applications and case histories to help you use this versatile silicone rubber to best advantage in your application. *No. 442*

Silicone Coatings for Metal Products. An article reprint from MATERIALS AND METHODS provides a comprehensive review of current uses for all types of silicone finishes now available. Includes information on coverage, costs, and methods of application. A valuable aid in selecting the most suitable type of silicone finish for any particular application. *No. 443*

Silicone Materials in Appliance Design, a recent article in ELECTRICAL MANUFACTURING, lists a variety of applications for several different silicones in appliances, describes how silicones have made possible design changes heretofore impractical, and how they extend service life and dependability. *No. 444*

Parts and components made with Dow Corning Silicone Molding Compounds are lightweight, show excellent resistance to heat, and have good structural and electrical properties. Used as brush holders, collector rings, terminal boards, multiple lead connectors, heat dams for turbine driven alternator bearings, and aircraft brake shoe backing. *No. 445*



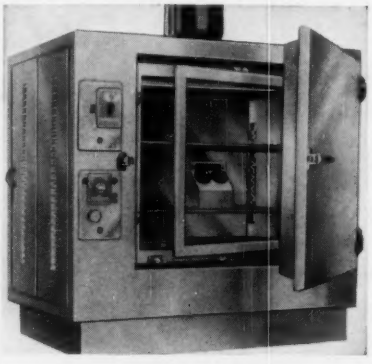
Silicone Fluids on Insulators Stops Shorts and Grounds

Imaginative use of a silicone fluid has enabled Blue M Electric Company, Blue Island, Ill., to engineer faster response and more accurate heat control into its laboratory humidity cabinets.

Moisture condensation on the steatite grommets that support the resistance wire heating elements was always a problem in these cabinets. Moisture caused such a low resistance to ground that the elements had to be sheathed. This, of course, reduced the heat-up speed and made it more difficult to maintain accurate temperatures in the cabinets.

Blue M now controls the condensation problem by simply coating the ceramic insulators with Dow Corning 200 Fluid. The resulting water-repellent silicone surface is so successful in preventing the formation of conducting moisture films that the treated insulators withstand 1000 volts to ground even with droplets of water on their surface. As a result, Blue M has been able to change to faster, more accurate "open" elements without fear of grounds or shorts.

Blue M uses a 2% solution of Dow Corning 200 Fluid in carbon tetrachloride. The insulators are dipped into this solution and baked for one hour at 575 F. *No. 438*



NEW ROTARY SWITCHES *(Cont.)*

According to Shallcross, silicone-glass laminate was chosen because of these outstanding properties:

1. Low moisture absorption.
2. Thermal stability which not only permits service in varying climates, but prevents terminals loosening during soldering.
3. Good surface resistivity.
4. Low dielectric loss for increased RF efficiency.

The silicone-glass laminate used in these switches is "Phenolite G-7-830," produced and sold by National Vulcanized Fibre Company. National fabricates the plates maintaining a tolerance of ±.005 inch in the punched holes. *No. 437*

ACID RESISTANT TAPE *(Cont.)*

contact between metal and acid, thus eliminating the need for glass stoppers.

In addition to facilitating handling and shipping, the new tape has reduced material and labor requirements sufficiently to actually cut overall packaging costs in half for Merck & Co. *No. 439*

Dow Corning Corporation, Dept. 6822, Midland, Michigan

Please send me: 436 437 438 439 440 441 442 443 444 445

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for product design and development engineers by

first in silicones

Dow Corning CORPORATION

MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D. C.

CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

or P face-type mounting bracket, is for applications such as turbine pumps and mixers. Designed for rugged industrial duty, drive provides long life and dependable performance. Windings are asbestos protected to resist heat and mois-

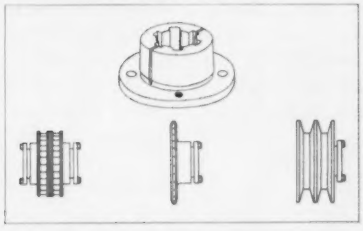
ture. One-piece, double-ribbed belt transmits power smoothly and absorbs shock loads and vibration. Drive is available from ¼ to 30 hp in ratios up to 10:1. **U. S. Electrical Motors Inc.,** Box 2058, Terminal Annex, Los Angeles 54, Calif.

Circle 674 on page 19

Spline-Bore Bushing

is available in six bore sizes

Spline-bore bushing provides a simple means of applying power transmission items to spline bore shafts on agricultural, construction, and industrial machinery. Bore sizes from ⅝-6 spline to 1⅜-10 spline are available in 16 models. Shown below bushing are typical coup-



ling, sprocket, and sheave mountings. **Browning Mfg. Co.,** Maysville, Ky.

Circle 675 on page 19

Power Supply

transistorized unit for two-way radio systems

This transistorized power supply replaces the receiver portion of the mobile power supply in two-way radio systems. Unit reduces the need for frequent replacement of

Circle 490 on page 19

New Parts

vibrators. Designed around a printed wiring board, it is 3½ in. wide, 4 in. long, and 1¾-in. deep. It weighs 12 oz and can be mounted on front exterior of a standard two-way radio case. Unit can be used with any standard mobile equipment using a 12-v power source in the 25-54, 144-174, and 450-470 mc bands. **General Electric Co.,** Communication Products Dept., Electronics Park, Syracuse, N. Y.

Circle 676 on page 19

Spaghetti Tubing

is of thin-wall Teflon

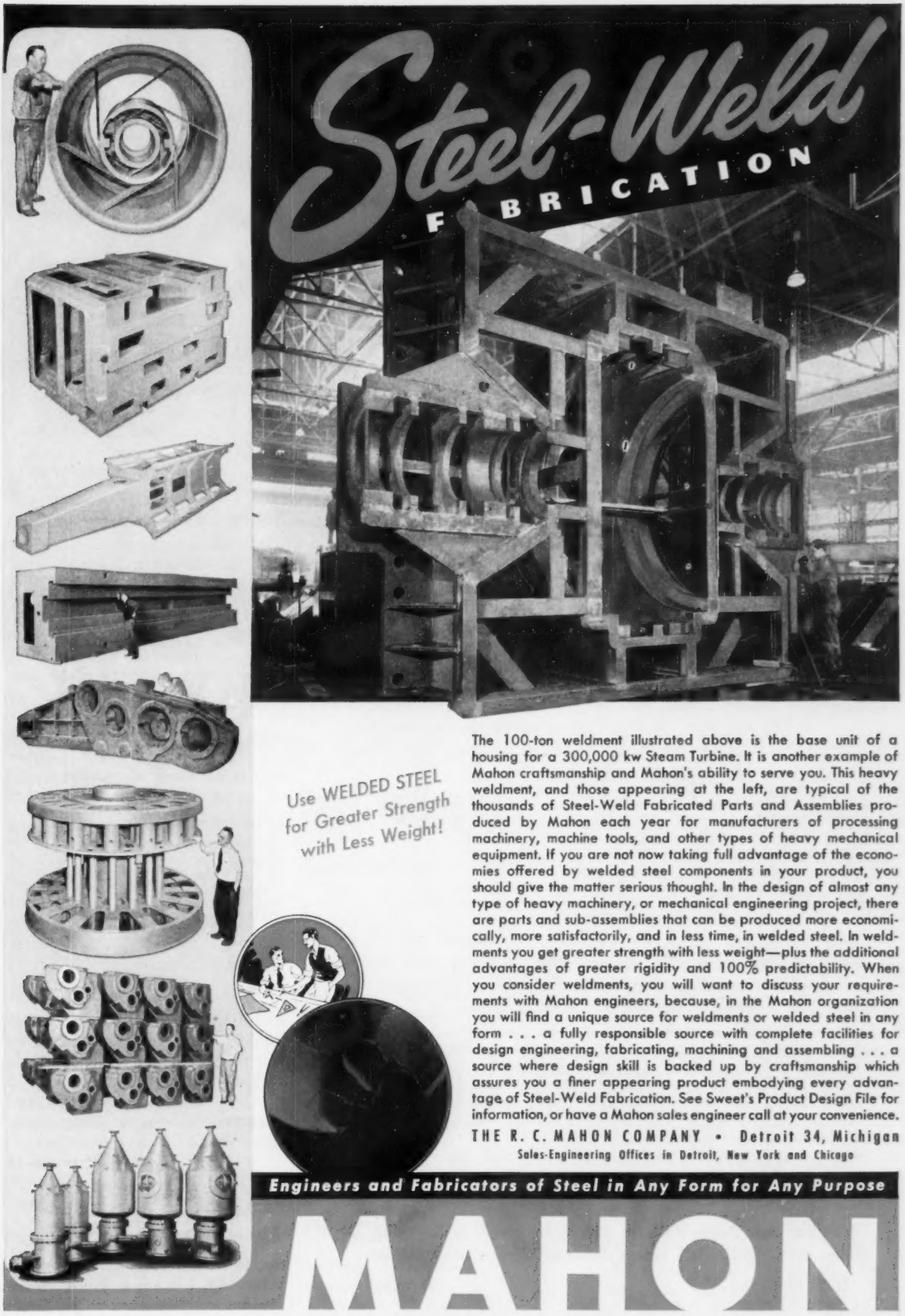
Microthin Teflon spaghetti tubing has excellent flexibility, yet retains strength and properties of heavy-wall type. Tubing is useful in the assembly of compact electrical and electronic components requiring sharp tubing bends in restricted corners. Heat resistance permits greater speed of assembly through use of high-speed soldering techniques. Temperature range is −450 to 550 F. Produced in standard color-coding range, tubing is available in wall thicknesses from 0.005 to 0.010 in., AWG sizes No. 30 through No. 0. **W. S. Shamban & Co.,** 11617 W. Jefferson Blvd., Culver City, Calif.

Circle 677 on page 19

Industrial Clamp

heavy-duty unit is worm-gear actuated

Industrial clamp for heavy-duty containers provides an air and moisturetight seal in steel, aluminum, plastic, or other containers. Worm-gear actuated, unit has ultimate closing strength to 200 lb. It withstands shock and vibration, and is infinitely adjustable to accommodate varying manufacturing tolerances. Rotation of locking nut



Use WELDED STEEL
for Greater Strength
with Less Weight!

The 100-ton weldment illustrated above is the base unit of a housing for a 300,000 kw Steam Turbine. It is another example of Mahon craftsmanship and Mahon's ability to serve you. This heavy weldment, and those appearing at the left, are typical of the thousands of Steel-Weld Fabricated Parts and Assemblies produced by Mahon each year for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. If you are not now taking full advantage of the economies offered by welded steel components in your product, you should give the matter serious thought. In the design of almost any type of heavy machinery, or mechanical engineering project, there are parts and sub-assemblies that can be produced more economically, more satisfactorily, and in less time, in welded steel. In weldments you get greater strength with less weight—plus the additional advantages of greater rigidity and 100% predictability. When you consider weldments, you will want to discuss your requirements with Mahon engineers, because, in the Mahon organization you will find a unique source for weldments or welded steel in any form . . . a fully responsible source with complete facilities for design engineering, fabricating, machining and assembling . . . a source where design skill is backed up by craftsmanship which assures you a finer appearing product embodying every advantage of Steel-Weld Fabrication. See Sweet's Product Design File for information, or have a Mahon sales engineer call at your convenience.

THE R. C. MAHON COMPANY • Detroit 34, Michigan

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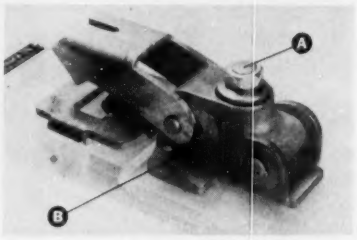
Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

Circle 493 on page 19

New Parts

A with standard 7/16 wrench turns gear B by worm-lock principle and closes clamp. Combination of links, bases, and striking surfaces can be worked out to almost any specific application. Clamp meets



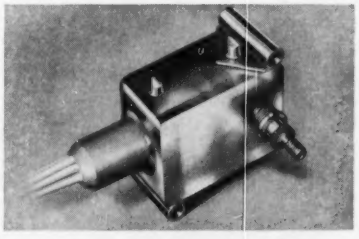
military drop, shock, and vibration tests. **Bassick Co.,** Specialty Hardware Dept., 437 Howard Ave., Bridgeport 2, Conn.

Circle 678 on page 19

Rotary Switch

has simultaneity within 1½ deg rotation

This rotary switch is designed for aircraft landing gear and engine controls, missile launchers, and radar and industrial equipment. It has a current capacity of 10 amp resistive, 30 v dc, 115 v ac. In C9178 model, shown, actuator shaft can rotate continuously 360 deg in either direction. Other models have limited-rotation shafts or are spring-returned. Unit has



simultaneity within 1½ deg rotation, excellent shock and vibration resistance, and is unaffected by ambient temperatures from −65 to 275 F. **Metals & Controls Corp.,** Spencer Thermostat Div., Attleboro, Mass.

Circle 679 on page 19

Cam Valve

in 1¼-in. size

Single-motion cam valve, for use where quick-opening globe valves are needed, combines an all brass

Prove by comparison tests that Parker O-rings seal better, last longer

Comparison tests will show you that Parker O-rings are better. You can't *see* the difference. You can't *feel* the difference. But in *use*, Parker O-rings actually do seal better and last longer!

Why? Because Parker O-rings are precision-molded of superior compounds developed by exhaustive research and experimentation. Our engineering service will help you with your particular problems — whether in gland design or compound. From Parker, you get the *right* O-ring for your *specific* application. Compare Parker O-rings and discover the difference for yourself.

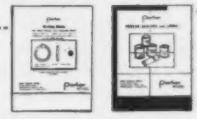
These trouble-free, leakproof seals are carefully evaluated for elongation, tensile strength, compression set ratings, resistance to oils, fuels, chemicals and temperature extremes. Exacting laboratory and service tests make sure that Parker O-rings meet applicable specifications. Whatever your requirements, Parker can supply the O-rings you need.

Ask your Parker O-ring distributor today for new O-ring Size Catalog or mail the coupon for your copy.

Parker

Hydraulic and fluid system components

Parker O-Lube is especially formulated for O-ring lubrication requirements. It comes in a handy, squeeze-tube container.



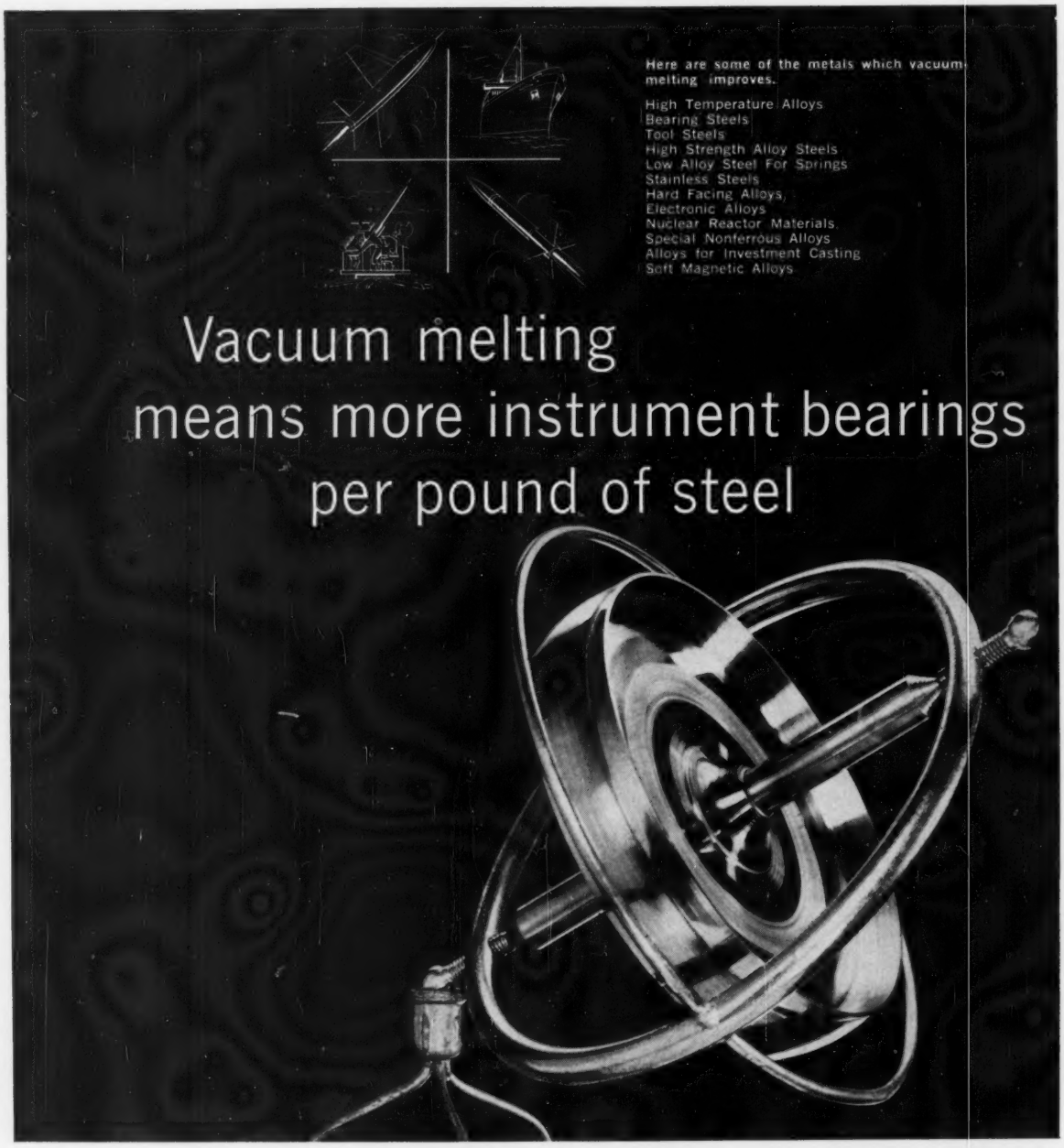
RUBBER PRODUCTS DIVISION, Section 525-V
The Parker Appliance Company,
17325 Euclid Avenue, Cleveland 12, Ohio.
1538 South Eastern Ave., Los Angeles, Cal.

Please send:

☐ O-ring Size Catalog No. 5701
☐ O-Lube Catalog No. 5840

NAME _____ TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ STATE _____

Circle 495 on page 19



Gyros are the heart of many modern navigation and fire-direction devices. The ball bearings used in these gyros are expensive to manufacture, for, with air-melted alloys, rejects average 15%. *But with vacuum-melted alloys, rejects of finished balls have dropped to less than one percent.* Here's why:

Surface finish is better because vacuum-melting reduces inclusions to the lowest level commercially possible . . . properties of the steel are more uniform in all directions and from heat to heat . . . fatigue, impact and ductility are substantially improved. Specifically, 52100, 51100, 440-C and similar grades are being used in production quantities for the most critical bearing applications.

Vacuum Metals Corporation, Division of Crucible Steel Company of America, is the first and largest producer of vacuum-induction melted metals. VMC produces a wider variety of alloys than any other company. And it is now doubling its capacity to meet increasing demand from industry. A VMC engineer will be glad to work with you on metals problems which vacuum-melted metals may solve. Please write, giving as much data as possible, to Vacuum Metals Corporation, Division of Crucible Steel Company of America, P. O. Box 977, Syracuse 1, N. Y.

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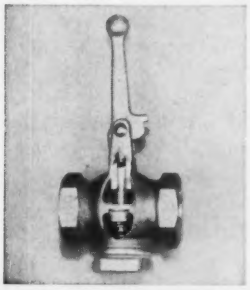
Circle 496 on page 19



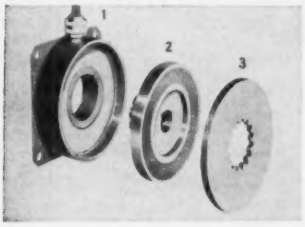
body with manganese-bronze lever handle. Stainless-steel spring and plunger have an O-ring seal, and neoprene is used for seat washer. Steel insert cap on plunger top provides long wear and easy action. Unit is available in 1¼-in. size. **Rockford Brass Works,** Rockford, Ill.

Circle 680 on page 19

Stationary-Magnet Clutch

with torque range from 25 oz-in. to 170 lb-in.

Stationary-magnet clutch consists of magnet body, drive member, and driven member. It is available in diameters from 1⅜ to 5 in., with torque ranges from 25 oz-in. to 170 lb-in. Clutch is wound for direct current, with maximum ratings from 28 to 90 v, depending on size of unit. Stationary magnet eliminates collector rings, and friction linings permit high torque values. Clutch is easily adapted to machine tools, electronic computers, motion picture cameras, and other applications. **Stearns Electric Corp.,** 120 N. Broadway, Milwaukee 2, Wis.



Circle 681 on page 19

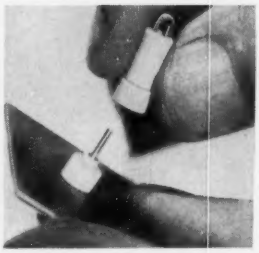
Jack and Plug

are miniature, high-voltage units

High-voltage jack with companion plug is available for elevated voltage requirements in miniaturized

New Parts

assemblies. Jack has Teflon body and contact members of machined beryllium-copper, with gold flash over silver plate. Jack and companion plug are rated at 5000 v rms at sea level, or actual flashover of 11,000 v and 1400 v at 50,000 ft. Teflon body provides insulation over temperature range of −65 to 200 C. Jack and plug can



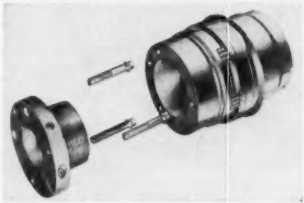
be mounted directly on metal chassis or casing for high-voltage breakaway connections. They are available in eight RETMA code colors. **Sealectro Corp.**, 610 Fayette Ave., Mamaroneck, N. Y.

Circle 682 on page 19

Flexible Couplings

for use with QD taper bushings

Six sizes of flexible couplings, taper-bored for use with taper bushings, have ratings ranging from 22 to 150 hp at 1750 rpm. Bushing bore sizes run from ½ to 3½ in. Coupling-bushing combination per-



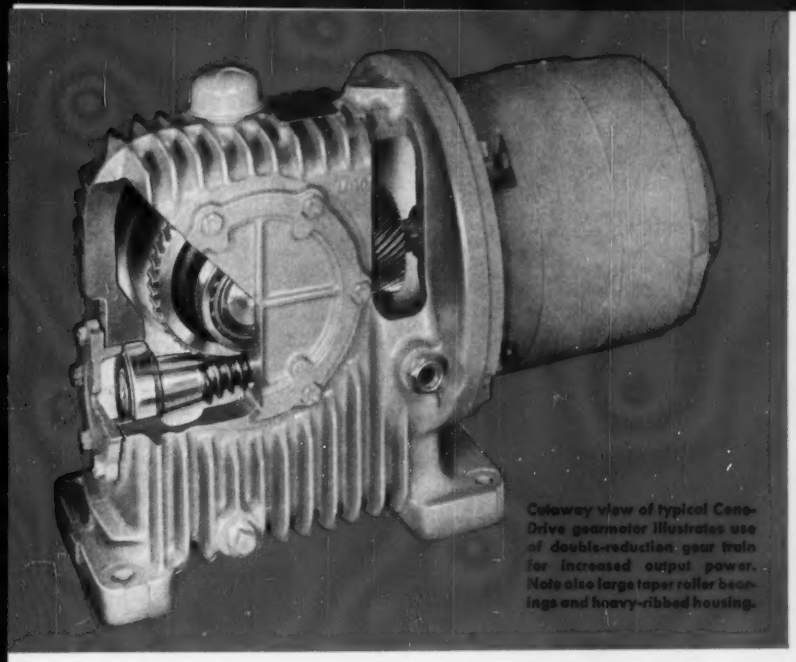
mits fastening to shaft with firmness of shrunk-on fit. **Lovejoy Flexible Coupling Co.**, 4882 W. Lake St., Chicago 44, Ill.

Circle 683 on page 19

Metal Nameplates

adhere in temperatures from −62 to 325 F

Deep-anodized, self-bonding metal nameplates, designated Quik-Plates, have permanent pressure-sensitive adhesive that requires no



Cutaway view of typical Cone-Drive gearmotor illustrates use of double-reduction gear train for increased output power. Note also large taper roller bearings and heavy-ribbed housing.

Announcing a POWERFUL NEW DRIVE *by* CONE-DRIVE GEARS

Here are the "why's" for this new gearmotor

Why a right-angle gearmotor?
You save space! By tucking the entire unit in close to the driven shaft, there's nothing to stick out in crowded aisles. It's out of the way.

Why a double-reduction design?
More power! Combining a helical primary with a Cone-Drive double-enveloping worm gear secondary gives you an extremely high load-carrying capacity. Output torque ratings are much higher than those of single reduction gearmotors. Overall ratios are greater, too.

Why double-enveloping worm gears?
More power! Cone-Drive double-enveloping worm gears have proven that they provide maximum load carrying capacity on extremely small center distances. This means, in many cases, that they will handle two to four times the load of cylindrical worm gears of the same size. An added plus is high resistance to shock loads, long operating life and minimum maintenance requirements.

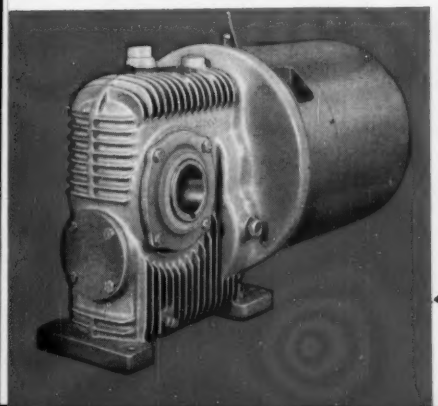
Why different types of mountings?
Flexibility! You can select Cone-Drive gearmotors with extended shaft or for shaft mounting. Both are standard. Shaft mounting often permits "hanging" the driven load on the gearmotor to eliminate pillow blocks, bearings, torque arms, shafts, pulleys, bed plates, etc. Both types may be floor, wall or ceiling mounted as desired.

Why 27 standard output speeds?
Standardization! Standard reductions range from 3.3:1 to 240:1. Speeds at 1750 rpm input range from 525 rpm to 7.3 rpm output speed. Any variation in input speed will naturally provide another complete set of 27 output speeds. Any standard type NEMA D-flange motor may be used. Other reductions may be obtained on special order at additional cost.

Why ratings to only 25 horsepower?
Demand! Extensive market research by Cone-Drive Gears reveals that this is the most popular power range in the application of gearmotors by industry. Currently we are building models in capacities from 1 to 25 horsepower. However the compact size and high capacity of the Cone-Drive gearmotor will extend this range in the future. Space requirements for higher capacities will be substantially reduced with our new design.

Why a Cone-Drive gearmotor?
Dependability! For over 20 years Cone-Drive Gears has been building double-enveloping worm gears and speed reducers. Design and manufacturing techniques have been constantly improved so that today these unique gears provide, size for size, the highest load-carrying capacity of any right angle worm gearing. Now, you can take advantage of this outstanding gearing combined into an integral package that eliminates pulleys, sheaves, belts, chain, bearings and all the trouble that goes with separate reducer and motor combinations. You'll get increased efficiency at lower cost by specifying standard Cone-Drive gearmotors.

Bulletin #57 contains complete details. Ask for it today.



◀ Here's the finest shaft mounted gearmotor on the market today. It is available in all sizes with ratings identical to other Cone-Drive gearmotors.

CONE-DRIVE GEARS
Division, Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNICHOLS ROAD • DETROIT 12, MICHIGAN

Circle 499 on page 19

New Parts

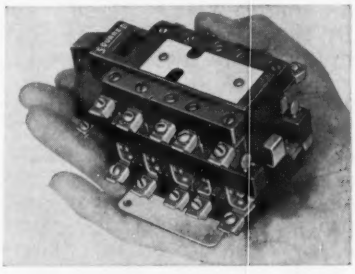
activation by water, solvent, or heat. It adheres instantly to metal, glass, plastic, and wood, and to painted smooth, flat, wrinkled, and curved surfaces. Plates are 0.004 in. thick aluminum and are available in a wide range of colors with glossy or matte finish. Legend will not tarnish, peel, crack, or crumble off. Plates remain bonded to surfaces through temperature range of −62 to 325 F. They meet military specifications for abrasion resistance, salt spray, and humidity. **W. H. Brady Co.**, 727 W. Glendale Ave., Milwaukee 9, Wis.

Circle 684 on page 19

Ten-Contact Relay

is 5 in. high and 3 in. wide

Class 8501 Type D 10-amp relay is available in a ten-contact size. It has a maximum of six normally-open and four normally-closed, or eight normally-open and two nor-



mally-closed contacts. Since relay measures only 5 in. high by 3 in. wide, it is useful where panel space is at a premium. **Square D Co.**, 4041 N. Richards St., Milwaukee 12, Wis.

Circle 685 on page 19

Shaded-Pole Motor

has length of less than 4 in.

Slim, lightweight shaded-pole motor is for use in blowers, cooling fans, evaporative coolers and air conditioners. Length of the two-bearing unit is less than 4 in., and it weighs 5.5 lb. Motor provides ventilation openings in both shell and end shields. Increased air flow over windings and bearing housings lowers operating temperatures. Motor is available in ratings

TIMERS...SPECIAL DELIVERY

Standard or special— Industrial Timer makes rapid deliveries on all models

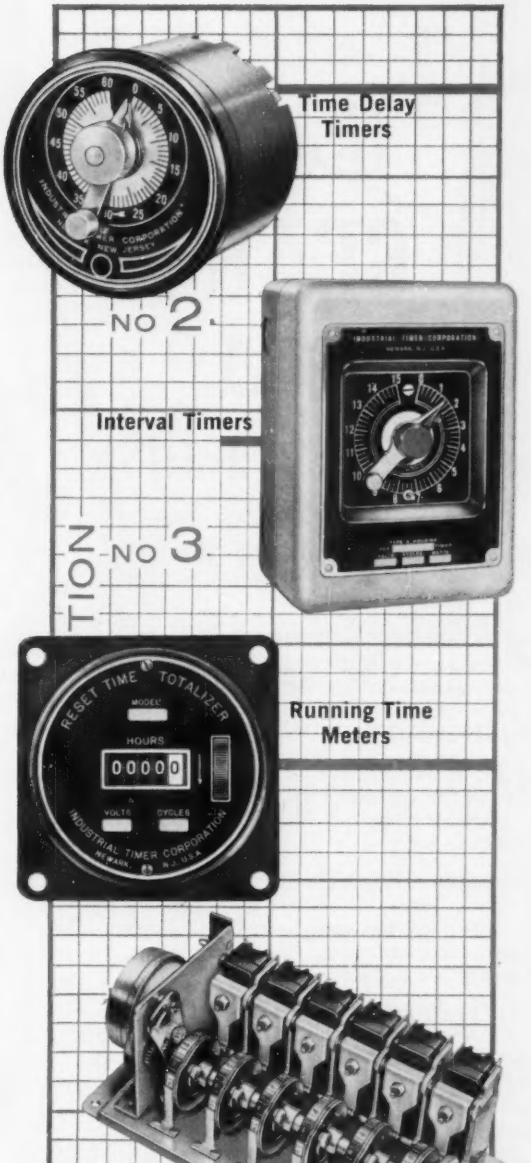
Sometimes you need a standard model timer . . . other times you need a special. Either way we can give you the extra rapid service you may need because of the efficient way we design, manufacture and stock timers for industrial applications.

To meet *all* of the widely varying needs of our customers we manufacture a complete line of timers in the four broad classifications illustrated here:

1. TIME DELAY TIMERS
2. INTERVAL TIMERS
3. RE-CYCLING TIMERS
4. RUNNING TIME METERS

From these we have already developed 20 basic types which can be combined in endless number of ways . . . to date, our engineers have combined them into over 1000 different models. So what might seem to be a special timer requirement to you, will very often be a standard timer in our large stock, and that is the reason we have the ability to fill special orders so quickly. And as far as standard timers are concerned we can give overnight service if necessary.

So, for the utmost in all-round service depend on us for this outstanding combination: deliveries "Immediate on Standards . . . First on Specials".



Speed up your automatic control projects— profit by our timing application experience

No need to let timing problems delay you in your automatic control projects when you can place them with us and get faster solutions. Even though no two automatic control jobs are ever exactly alike, and even though the timer requirements of each are very different we have established an excellent record in helping out in these situations.

20 years of experience in analyzing complex timer applications has provided us with the special knowledge required to give our customers the right answer in near-record time.

Our large stock of standard and combination timers enables us very often to fill orders for these requirements without any time loss because we have already developed so many new combinations specifically for automatic control functions.

Extra special automatic control timer — this calls for original designing. Our engineers will go right to work and get the job done. That's the way we grow and we like it.

Whatever your control problem, you have everything to gain by submitting it to our timer specialists. They'll come up with the answer — almost with the speed of automatic control itself.

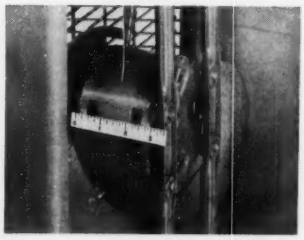
Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
1413 McCARTER HIGHWAY, NEWARK 4, N. J.

Circle 501 on page 19

New Parts



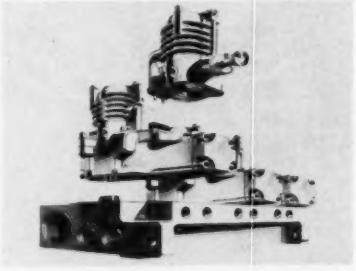
to 1/10 hp in four and six-pole sizes. Design permits one, two or three speeds in either direction or both. **General Electric Co.**, One River Rd., Schenectady 5, N. Y.

Circle 686 on page 19

Control Valves

have built-in plugs and connectors

Speed King plug-in type ¼-in. four-way control valves are available in both single and double-solenoid types for manifold sub-base mounting. Plug - in connectors built into pilot, valve body and manifold or sub-base complete electrical connections as components are bolted in place. Designed for control of smaller devices, valves are available with solenoid coils for ac or dc, any voltage, for 30-250 psi air service. Solenoid pilots are interchangeable between single



and double-solenoid types. Pilot plungers and valve stem are only moving parts. **Valvair Corp.**, 454 Morgan Ave., Akron, Ohio.

Circle 687 on page 19

Packaged Bridge Circuit

incorporates miniature resistors and potentiometer

Designed to operate at ambient temperatures to 125 C and altitudes to 60,000 ft, miniature strain gage balance circuit provides space and weight-saving benefits to aircraft and missile electronic systems. It

Circle 502 on page 19

ENTER THIS CONTEST ...90 CASH PRIZES!

CONTEST RULES

1. Tell in 25 words or less "Why I prefer Albanene tracing paper."
2. Send all entries to K&E Albanene Contest, Box 160, New York 46, N. Y. Enter as often as you wish. There is nothing to buy.
3. Entries must be postmarked not later than midnight, Nov. 30, 1957.
4. Entries become the property of Keuffel & Esser Co. None can be returned.
5. The decision of the judges is final.
6. Winners will be notified by mail. A complete list of winners will be sent upon request, providing request is accompanied by stamped, self-addressed envelope.
7. Contest is open to all residents of continental United States, except employes, and their immediate families, of Keuffel & Esser Co. and its subsidiaries and dealers; its advertising agency; and judges of this contest.
8. Also not applicable to residents of those states where there are prohibitory laws.

Why I prefer ALBANENE® Tracing Paper...

First prize $1500
Second prize $1000
Third prize . . . . . $ 500

plus 87 prizes of $25 each!

In 25 words or less, tell us why you prefer K&E Albanene® tracing paper. Your reasons may win one of these 90 prizes (it's K&E's 90th anniversary).

Here's a hint: Albanene is made from 100% rag stock for superlative tear strength. It is permanently transparentized with an inert resin. Draftsmen like it because of its easy drawing qualities . . . reproduction men for its high transparency and permanence. Everybody likes it because "what you pay for stays in the paper." That's why Albanene is the best seller among *all* tracing papers.

Get contest aids from your K&E dealer: Information booklets, extra contest entry blanks, samples of Albanene, too, if you need them. You can enter as often as you please.

Or use a plain sheet of paper if someone's already snipped the blank below. Give your name, address, and firm name, twenty-five words or less telling why you prefer Albanene tracing paper, and mail to K&E Albanene Contest, Box 160, New York 46, N. Y. before midnight, November 30, 1957.

KEUFFEL & ESSER CO.
New York, Hoboken, N. J., Detroit, Montreal, Chicago, St. Louis, Dallas, San Francisco, Los Angeles, Seattle.
Dealers in principal cities

K & E Albanene Contest, Box 160, New York 46, N. Y.

Here's why I prefer Albanene Tracing Papers_____

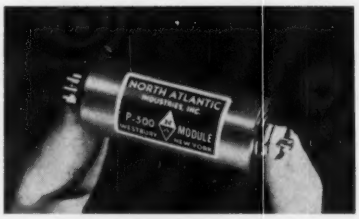
_____

_____

*Name*_____ *City*_____ *Zone*_____ *State*_____

*Street*_____ *Firm Name*_____

New Parts



achieves precise calibration and adjustment through the use of miniature resistors and a miniature potentiometer. Unit is available in a range of sizes, with light, rigid metal case which can be color-coded. It is equipped with male or female miniature connectors in one or both ends. Circuit is available in ruggedized commercial form and to military specifications. **North Atlantic Industries Inc.,** 603 Main St., Westbury, L. I., N. Y.

Circle 688 on page 19

Photo-Formed Parts

are etched to close tolerances

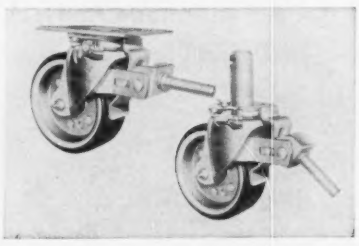
Chemical and electrolytic etching are used in photo-formed parts such as filters, strainers, dials, cams, pointers, linkages, gears, and diaphragms. Parts are free from distortion and burrs and are held to close tolerances. Metals which can be etched include stainless steel, carbon steels, copper-base alloys, nickel and nickel alloys, aluminum and aluminum alloys, and molybdenum. Materials in all tempers except very thin annealed strip can be processed. **Superior Tube Co.,** Photo-Forming Dept., Norristown, Pa.

Circle 689 on page 19

Scaffold Casters

have double-acting locks

Series C900 swivel-stem and CP900 swivel-plate casters combine double ball-bearing swivel and simultaneous locking of both swivel and



SIMPLIFY MACHINE DESIGN WITH THIS *Different* AIR CYLINDER

Save design time — save production costs. Eliminate cams, levers, gearing, linkages or other mechanical means for performing push, pull or lift motions. Design with air in mind.

The Bellows Air Motor is a complete electrically-controlled air cylinder power unit with directional valve and speed controls built in. It requires only one air connection which can be made with flexible hose. Compact, space saving, it fits well into crowded quarters or on moving machine elements. It is fast, responds to a starting impulse instantly. It is easily interlocked and synchronized with related machine movements. Its quality and reliability has been proven in more than quarter of a million installations.

The range of work it can do is limited only by the imagination of the design engineer.

Send for this free booklet

Here in these quick reading pages is the full story of The Bellows Air Motor — what it is doing for others, what it can do for you. Address Dept. **MD1057** The Bellows Co., Akron 9, Ohio. Ask for Bulletin BM-25. In Canada, write Bellows Pneumatic Devices of Canada, Ltd., Toronto, Ontario.

765-B

The Bellows Co.
AKRON 9, OHIO

Circle 505 on page 19

Circle 506 on page 19

New Parts

wheel action. Both styles are available with drawn-steel, semi-steel, rubber-tired, vulcanized or Ruberex wheels in 5, 6, and 8-in. sizes. Load capacities range from 240 to 650 lb per caster. **Faultless Caster Corp.,** 1521 N. Garvin St., Evansville 7, Ind.

Circle 690 on page 19

Level-Indicating Switch

is extremely adaptable unit

Model 1800 Universal level-indicating switch is adaptable to practically any tank, vessel, or container where a topping or low-level alarm or other level-indicating device is desired. It can be arranged to operate a remotely located warning light or other visual or audible alarm, to start or stop pump motors automatically, or to actuate automatic interlocking devices for the protection of equipment or operator. Switch consists of a foam

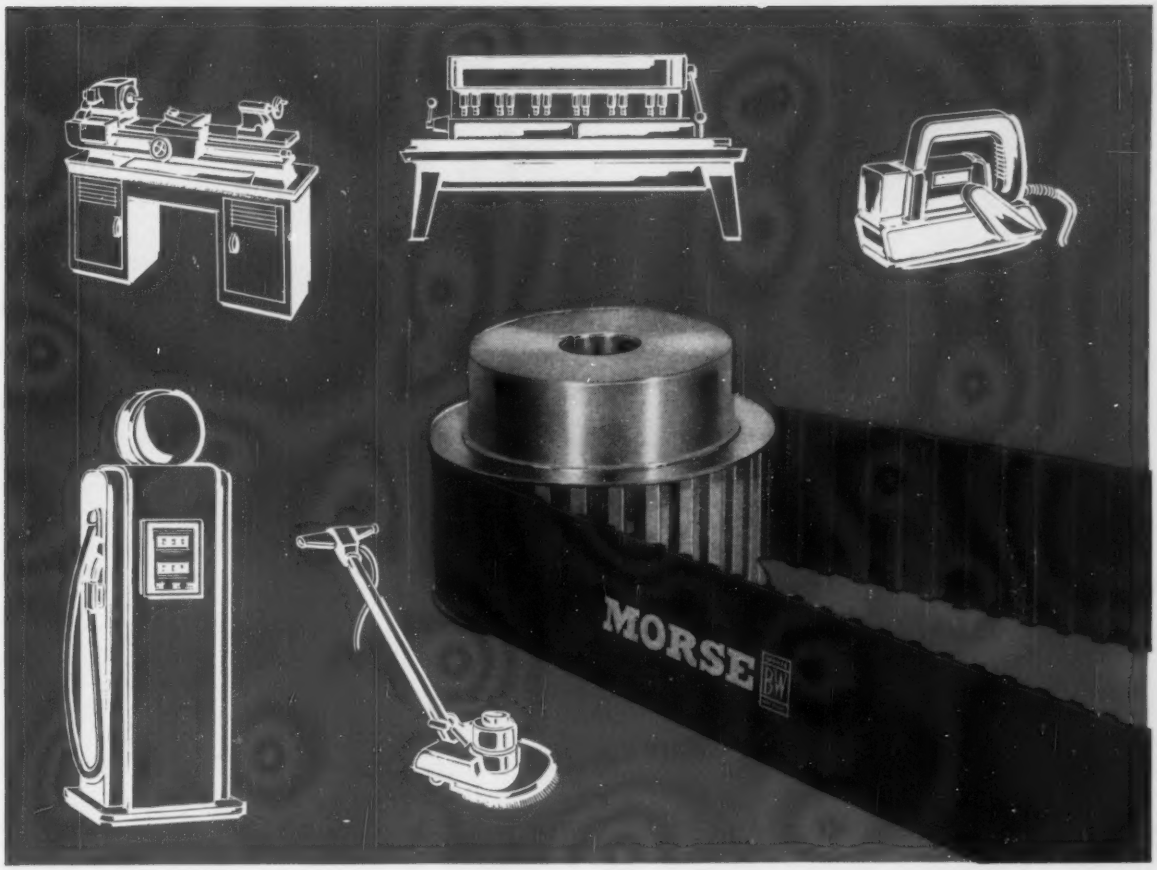
Buna-N float riding on a short, metallic stem. It is convertible from normally open to normally closed by reversing float on stem. Unit operates on any input from 1 to 220 v ac or dc, permitting use in permanent installations or in portable probes. **Gems Co.,** Wells Drive, Newington, Conn.

Circle 691 on page 19

Brakes and Clutches

are operated electromagnetically

Dyna-torQ units are electromagnetically operated, disc-type friction brakes and clutches. They operate on the principle of electromagnetic engagement of two friction members—armature and field magnet—to develop driving or braking torque. Controls are sim-



New! . . . from Morse Chain

Morse "Timing®" Belts

Stronger, lighter, slip-proof drives from the longtime leader in power transmission!

EXCLUSIVE!

Only Morse offers all 4 of these basic power transmission drives: Roller Chain, Silent Chain, Hy-Vo Drives, and "Timing" Belts. Your Morse distributor has no ax to grind in favor of one or two types of drives—he gives you a truly impartial analysis of your power transmission problems. Call him today!

Here's why *Morse* "Timing" Belts are important to *you:* For the first time, you can get these versatile, job-proved drives from a specialist with years of experience in every phase of mechanical power transmission!

Along with seasoned engineering know-how, Morse gives you the convenience of a complete line to choose from: 0-16,000 FPM; 1/1000 HP to 1,000 HP; in stock or made-to-order drives.

Whether or not you already use timing belts, it will pay you to get all the facts on *Morse* "Timing" Belts from your local Morse distributor. You'll find him listed in the Yellow Pages under "Power Transmission," or write: *MORSE CHAIN COMPANY, DEPT. 6-107, ITHACA, NEW YORK. Export Sales: Borg-Warner International, Chicago 3, Illinois.*

IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

MORSE* B-W

*Trademark

Circle 507 on page 19

NEW HAMMARLUND RADIO RECEIVER

FEATURES DIE CAST PANEL

CASE HISTORIES FROM MT. VERNON FILES

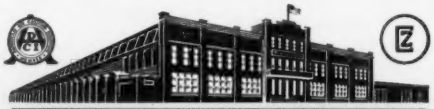
In their new HQ-100, Hammarlund Manufacturing Company brings to reality a completely new concept in receiver design. It is beautiful. It gives the radio amateur the utmost in performance. And it sells for far less than other comparable short-wave receivers.

A chief reason for this great economy is the front panel—the first die-cast panel in the history of commercial radio equipment. This 3-dimensional, channeled die-cast aluminum panel is used because it affords both rigidity and great structural strength. To produce its equivalent in sheet metal —the currently used method in the industry—*would cost 4 times as much.*

This remarkable panel is the result of thorough collaboration between Hammarlund and the die-making experts at Mt. Vernon, who made practical suggestions which simplified its design.

In addition to the production economies of die casting, the panel benefits from these other important advantages: (1) Die casting's inherent accuracy enables Hammarlund to assemble the chassis with what they call "camera precision construction." (2) All rejects on the production line are eliminated. (3) In finishing—die casting enables them to work out clearly divided areas for the elegant two-tone treatment that is both functional and beautiful. Also, the amount of finishing is minimized.

When you are out to break precedent, as Hammarlund did, you too can find the kind of skilled help you need in the complete service available from Mt. Vernon's coordinated designing, die-making, casting, and machining facilities, all under one roof, which can supply die cast zinc and aluminum parts ready for use. A switch to a die casting service like ours may be your next step. Let's discuss it.



MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT

SALES REPRESENTATIVES

Mr. Grant Eller
6 East 194th St., Cleveland, Ohio

Mr. Jerome J. Theobold
9 East Genesee St., Skaneateles, N. Y.

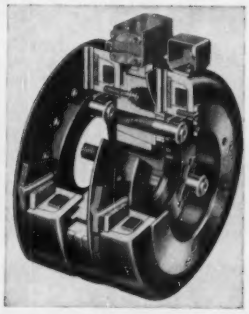
Mr. Anker Anderson
Cascade Road, Stamford, Connecticut

Mr. William Sauers
101 Briarcliff Road, Rochester, N. Y.

Mr. David King
230 Grant Boulevard, Syracuse, N. Y.

Mr. George E. Hahl
39 South Munn Ave., East Orange, N. J.

Circle 508 on page 19



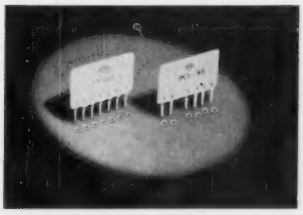
ple and can be remotely mounted to conserve space on processing equipment. Four units, available in a wide range of capacities, are the basic clutch, basic brake, clutch-brake, and clutch-coupling. Corresponding parts of all units in a given size are completely interchangeable. Brakes and clutches have application in machine tools, material handling equipment, packaging machines, textile and paper processing equipment, and in other industries. **Eaton Mfg. Co.**, Dynamic Div., Kenosha, Wis.

Circle 692 on page 19

Narrow Tab Terminals

for printed or etched-board circuitry

These terminals are designed for easy plug-in to 0.055-in. holes with perfect alignment of terminals on 0.172-in. centers. They are for use with printed or etched-board cir-



cuitry, and can be inserted automatically or manually. **Globe-Union Inc.**, Centralab Div., 900 E. Keefe Ave., Milwaukee, Wis.

Circle 693 on page 19

Metal Screw

is Mylar insulated

Sleev-Scru fastener consists of a metal screw with shank insulated by an integral cladding of Mylar polyester film. Screw can be any

(*Please turn to Page* 184)

compact . . . power-packed

New General Electric

REDUCE YOUR

COMPLETE LINE AVAILABLE

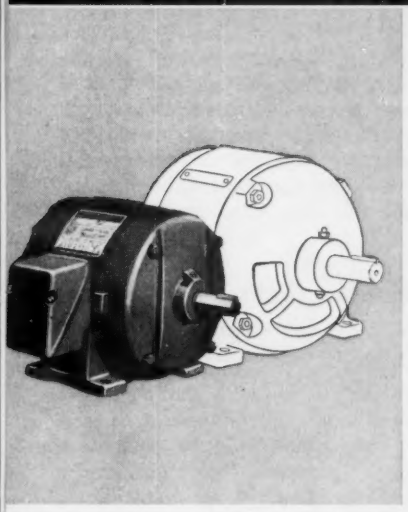
INSTALLATION EASE is one cost-saving feature of new Tri-Clad '55' motors 7½-125-hp. Up to 32% lighter and 50% smaller, these motors offer greater handling ease. Easy-access conduit box and perma-numbered leads speed motor hook-up to help reduce your product cost.

TRI 55 CLAD motors can...

REG. U.S. PAT. OFF.

PRODUCT COST

THROUGH 125-HORSEPOWER



UP TO 32% LIGHTER and 50% smaller, new Tri-Clad '55' motors make it possible to reduce the size and weight of your products, or, with minor design modifications get greater capacity out of present machines.

"SPECIAL" MOTORS are built in G.E.'s new motor factory almost as fast as standards. Orders for "specials," such as this Tri-Clad '55' brake motor with plugging switch, are normally filled and shipped within a few days.

IMMEDIATE SHIPMENT of all popular Tri-Clad '55' motor ratings through 125-hp is provided by G.E.'s modern production facilities and a nation-wide network of warehouses. Fast shipment cuts your inventory costs.

immediate shipment . . . all ratings

Today's highly competitive market demands that equipment manufacturers take every possible step to reduce costs while maintaining or increasing product quality.

To help you accomplish this objective, General Electric has extended the proven Tri-Clad '55' motor line (formerly available only through 30-hp) up through 125-hp.

DESIGNED TO NEW NEMA RATINGS, the *complete* line of Tri-Clad '55' motors packs *more* power into *smaller* enclosures to improve your product design, reduce shipping costs and benefit your overall operation.

In addition, G.E.'s modern, automated manufacturing plant and nation-wide warehousing facilities make it possible to *reduce your motor inventories.* Now, *any* frame size of *any* popular Tri-Clad '55' motor rating through 125-hp is available for immediate shipment from nearby warehouse or factory stocks.

FOR COMPLETE DETAILS on the new, complete Tri-Clad '55' motor line contact your nearest G-E Apparatus Sales Office or Authorized Distributor.

Section C891-8
General Electric Company
Schenectady 5, New York

Please send me the following publications:

☐ **FREE BULLETIN (GEA-6602) describes the many advanced features of new Tri-Clad '55' motors through 125-hp.**

☐ **FREE SLIDE RULE (GEN-148) to determine weight and space-saving benefits of new Tri-Clad '55' motors.**

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY & STATE _____

Progress Is Our Most Important Product

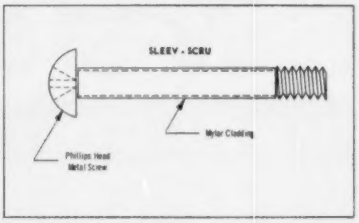
GENERAL ELECTRIC

Circle 510 on page 19

New Parts

(*Continued from Page* 181)

metal, such as brass, aluminum, or steel, depending on requirements. Applications include use in relay or contact blade stacks. Diameter of insulated shank is the same as



the OD of threaded section of the screw, permitting smaller assembly holes and narrower width of blades and spacers. Screws are produced to specific requirements. **Pylon Co. Inc.**, Attleboro, Mass.

Circle 694 on page 19

Pump-Motor Units

packaged units have 20 to 300-gph capacities

Positive-displacement pump and driving-motor units can be used in varying combinations for hydraulic, oil burning, lubricating and other services involving many different fluids. They are close-coupled, with pump mounted on motor. Pumps range in flow capacity from 20 to 300 gph and in

pressures to 1500 psi. Combinations include ¼-hp and larger motors. **Tuthill Pump Co.**, 939 E. 95th St., Chicago 19, Ill.

Circle 695 on page 19

Teflon Skived Tape

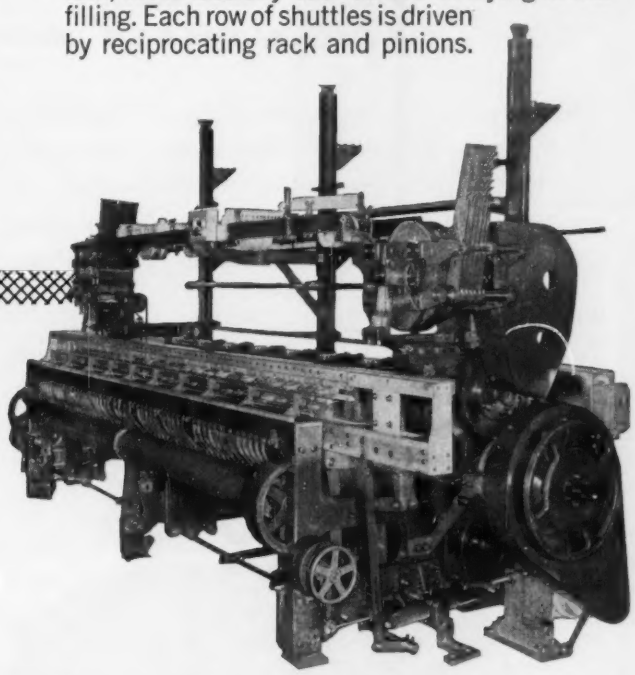
for wire and cable wrapped insulation

Teflon electrical skived tape for wire and cable wrapped insulation has zero moisture absorption. It is tough and flexible through temperature range of −400 to 500 F,

HEIM *Unibal*

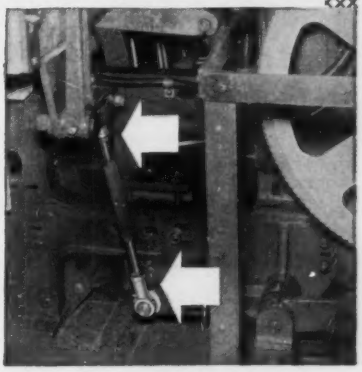
spherical bearing rod ends

In the production of narrow fabrics, the lay on the Crompton & Knowles Narrow Fabric Loom is driven back and forth from front to back, and the shuttles, arranged in two rows, top and bottom, move laterally back and forth laying in the filling. Each row of shuttles is driven by reciprocating rack and pinions.



are Necessary

To take care of inherent misalignments due to the backward and forward motion of the lay, and the lateral motion of the rack rods, **it is necessary to use HEIM Unibal Rod Ends.**



Correcting operating misalignment is just one indispensable feature of Heim Unibal. They have a greater surface supporting area, and are able to carry heavier axial and thrust loads. They reduce friction and lost motion, and eliminate brinelling. They are economical to buy, easy to install, and have a wide variety of uses.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

Be sure you have the Heim Catalog showing sizes and load ratings

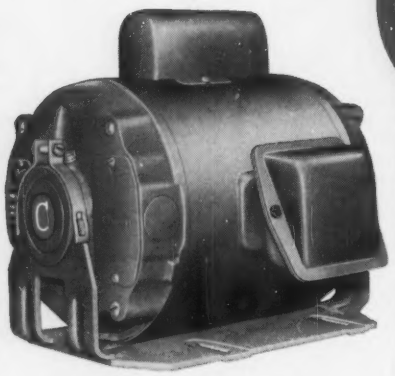
Send for a free sample so you can see for yourself this unusual, self-aligning Unibal principle.

Your choice of normal or low starting current...

with Performance-Rated

Century

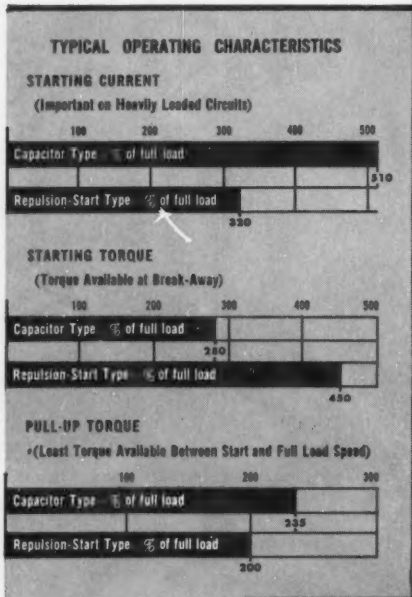
HIGH TORQUE, SINGLE-PHASE MOTORS

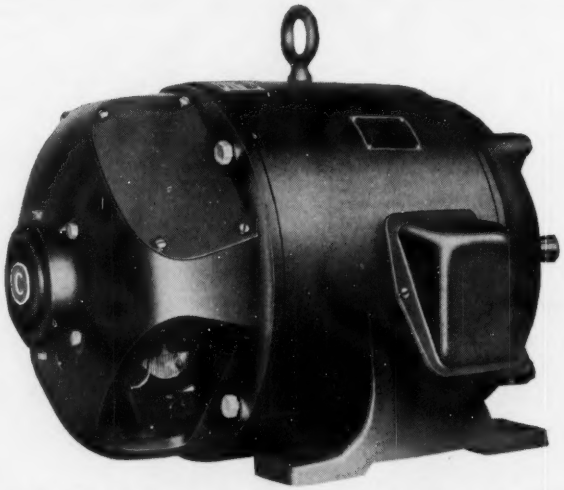


Capacitor Motors... ⅛ to 20 H.P. provide high starting torque, high pull-up torque and require normal starting current. They are available in drip proof, dust proof and explosion proof enclosures.

Even if you have severe starting current limitations, you can select the torque you need for sure starts and smooth pull-up to speed from the Century Performance-Rated Single-Phase line (see bar chart below for operating characteristics of two types of Century Single-Phase Motors).

Whatever Your Motor Job . . . there's a Century Motor Performance-Rated to handle it with top effectiveness. Contact your nearby Century branch office or Authorized Distributor.





Repulsion Start, Induction Motors (type RS)... ½ to 7½ H.P. provide very high starting torque, yet require unusually low starting current. They are available in drip proof and splash proof enclosures.

Performance-Rated© Motors ⅛ to 400 H. P.

CENTURY ELECTRIC COMPANY

CE-32

1806 Pine Street, St. Louis 3, Missouri • *Offices and Stock Points in Principal Cities*

Circle 513 on page 19

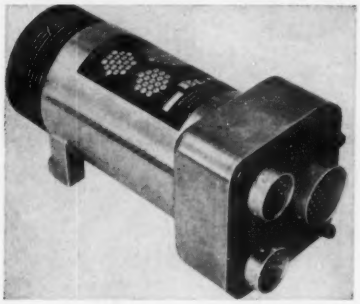
has tensile strength of over 2000 psi, and has elongation of over 400 per cent. Material has dielectric strength of 1000 to 2000 v per mil of thickness, and dielectric constant is 2.0 through entire frequency range. Tape is available in six widths from 3/16 to ¾ in. in thicknesses from 0.002 in. up. It is packaged in 7 to 8 or 8 to 9-in. rolls, on cores of 1½, 2, or 3 in. ID. **Dixon Corp.**, Bristol, R. I.

Circle 696 on page 19

Rotary Switch

is six-pole high-speed unit

High-speed, six-pole rotary switch has rated life of 1000 hr continuous duty at temperatures from −55 to 85 C. Unit is hermetically sealed, and all wiring is brought out at one end through three



quick-disconnect hermetic plugs. Commutator assembly is driven through a 13.3:1 gear reduction by a 400-cycle, 115-v, single-phase motor. **Instrument Development Laboratories Inc.**, 67 Mechanic St., Attleboro, Mass.

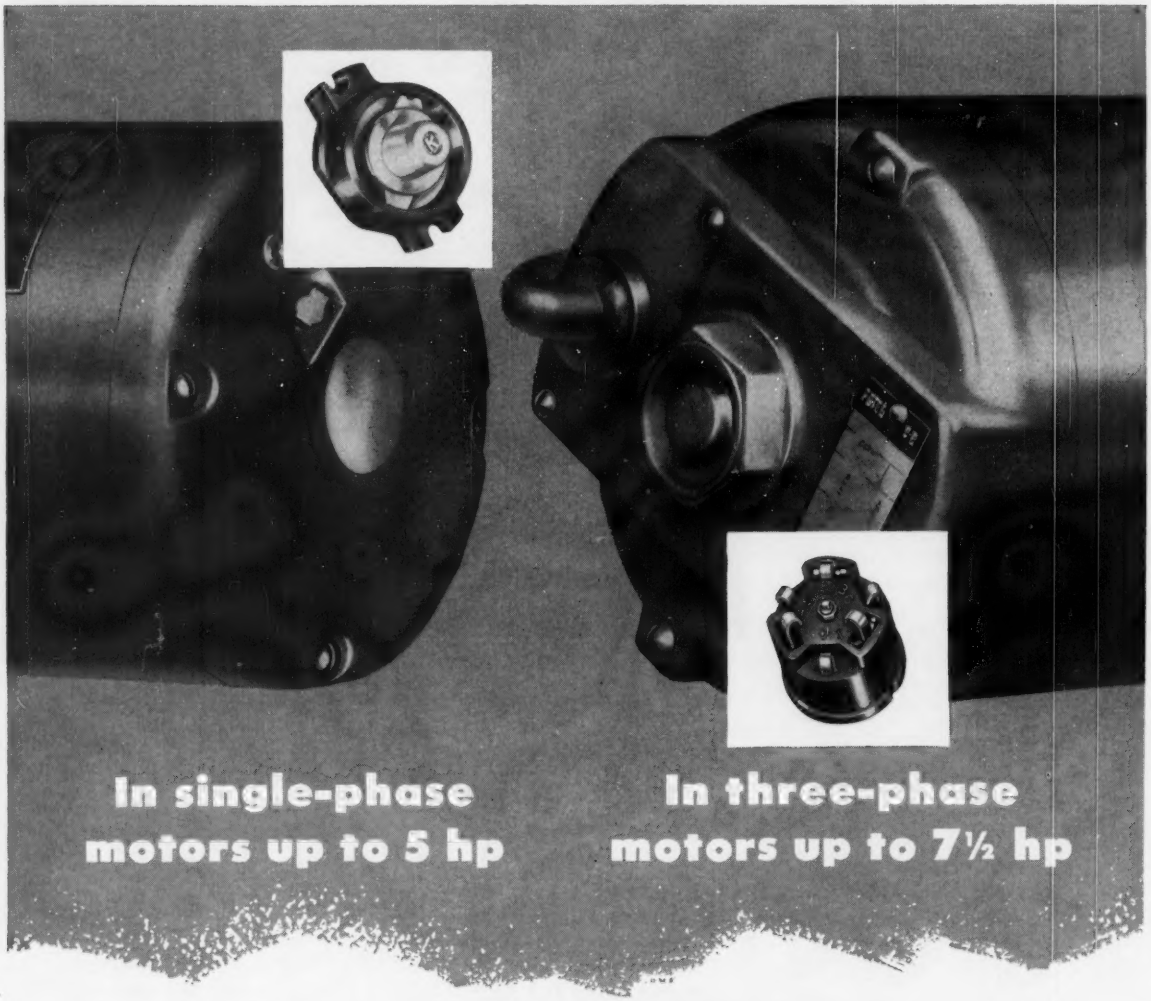
Circle 697 on page 19

Dry Bearing Material

for service at temperatures to 500 F

Chemloy bearing material is available for applications where lubrication is a problem. It is recommended for dry-bearing services, both sliding and rotating, at temperatures to 500 F. Material can be used with solvents, such as acetone, and virtually all corrosives. It will not permanently deform due to shock. Material has a static coefficient of friction against polished steel of 0.04 and PV factor up to 10,000. It withstands speeds

Circle 514 on page 19



KLIXON MOTOR PROTECTORS

mean maximum safe output, minimum down time

With the new Klixon Inherent Motor Protector for 3-phase motors, you now have available the same full safe capacity from polyphase motors that you have been getting for the past 20 years in single-phase motors.

Motor manufacturers are now able to supply Klixon built-in protection in standard 3-phase motors as well as in single-phase motors.

Motors protected with Klixon Inherent Protectors prevent overheating caused by:

- PROLONGED OVERLOADS
- STALLING
- FAILURE TO START
- LACK OF VENTILATION
- INCREASE IN AMBIENT TEMPERATURES
- PLUGGING OR REVERSING DUTY
- UNBALANCED VOLTAGE

Always specify and use motors — single and polyphase — with built-in Klixon Protectors.

Remember, Klixon automatic and manual reset protectors:

- √ REDUCE PRODUCTION DOWN TIME
- √ MINIMIZE MOTOR REPAIRS AND REPLACEMENTS
- √ ELIMINATE MOTOR BURNOUTS
- √ SIMPLIFY MOTOR CONTROLS
- √ ASSURE MAXIMUM SAFE MOTOR CAPACITY

METALS & CONTROLS CORPORATION

Spencer Thermostat Division 3210 Forest Street, Attleboro, Mass.

KLIXON

Circle 515 on page 19

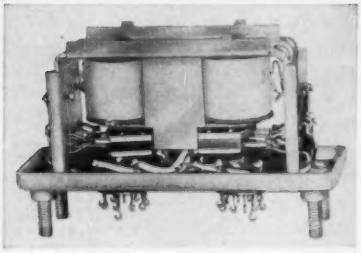
to 1000 fpm and loads to 100 psi. **Crane Packing Co.,** Dept. MDC, 6400 Oakton St., Morton Grove, Ill.

Circle 698 on page 19

Latching Relay

unit with permanent magnet resist shock and vibration

KG magnetic latching relay, designed to withstand high shock and vibration while operating on minimal power, employs a permanent magnet to hold armature securely in either contact position. Dual-coil relay resists 100 g shock, vibrations of 30 g acceleration from 55 to 2000 cps, and excursions of 0.195 in. from 10 to 55 cps with no contact opening. Relay requires only 2.0 w at nominal voltage for 12 milliseconds to effect armature transfer. Six-pole, double-throw hermetically sealed unit



is insulated with Teflon, ceramic and glass for ambient temperatures from −65 to 125 C. **Potter & Brumfield Inc.,** 1200 E. Broadway, Princeton, Ind.

Circle 699 on page 19

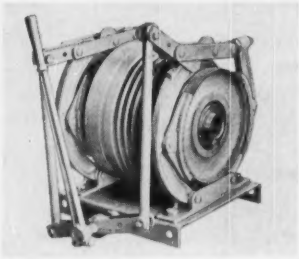
Reduction Pulley

is dual-clutch unit with interlock

Pulley with internal planetary gearing having speed reductions to 8000:1 provides two internally reduced speeds. Speeds can be in the same direction, or one forward and one reverse. They are controlled by two mechanical clutches, mount-

New Parts

ed on a base and operated by a common lever which provides interlocking operation. Unit is operated either horizontally or vertically, and is completely sealed. Overload release is provided by a roller in clutch mechanism which rides in an eccentric groove cut in



clutch drum. On overload the clutch drum slips, forcing up roller and opening clutch. Sizes available include 12, 18, 20, and 24-in. diameters with ratings to 120 hp. **Hart Reduction Pulley Co.**, 426 W. Main St., Waukesha, Wis.

Circle 700 on page 19

Drawn Aluminum Tube

in round, square, and rectangular shapes

Round aluminum alloy drawn tube is available in sizes from ¼ to 4½ in. OD, with wall thicknesses from 0.025 to 0.250 in., depending on alloy and temper. Square and rectangular products encompass a similar size range. Alloys available include 3003, 6063, 1100, 6061, and 6062, with 5052 and 2024 to be added. Tube has many applications, including manufacture of furniture, appliances, aircraft, automobiles, and building supplies. **Kaiser Aluminum & Chemical Sales Inc.**, 919 N. Michigan Ave., Chicago 11, Ill.

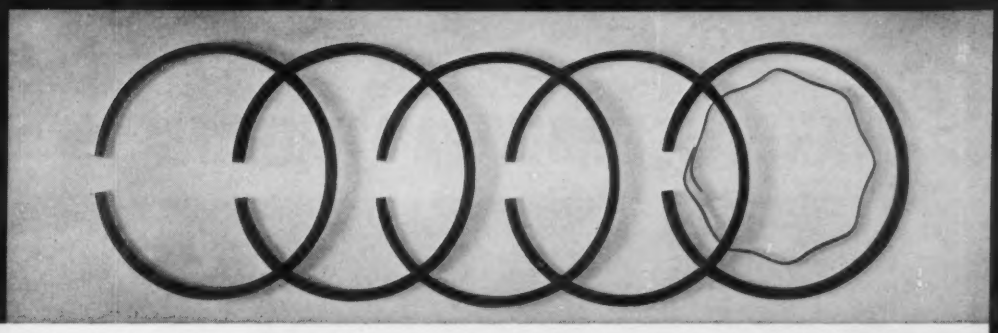
Circle 701 on page 19

Hydraulic Valve

provides shockfree directional flow control

Series 1701 hydraulic control valve incorporates a cylindrical screw-type slide plunger, actuated through a 28-v dc motor-driven two-stage gear train, to provide smooth, positive directional control. Design provides two-way control, with ½-in. slide travel. Valve meets

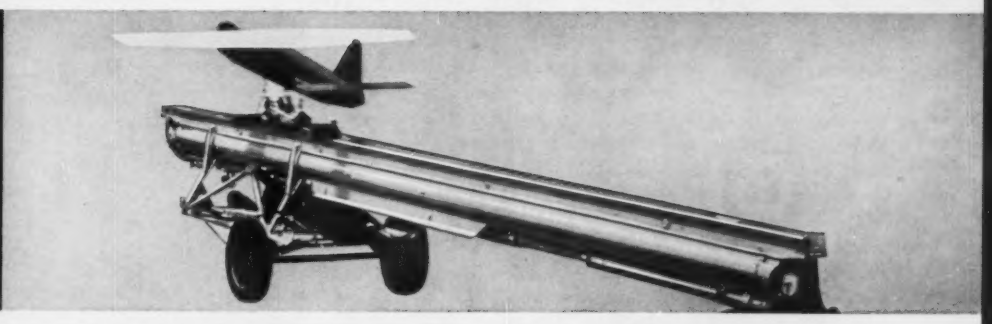
1. Do you recognize the value of these 5 rings?



2. What should a compressor have in common with this freight train?

3. It operates with no impact. Can you name the part?

4. What "fires" this Navy target drone?



WHAT'S YOUR C.Q.? (COMPRESSOR QUOTIENT)

1. You recognize these as being compressor piston rings. But perhaps you didn't know that the number isn't always the same. Many manufacturers, for example, use only four rings. Worthington, however, uses five rings – three compression and two oil. For lower oil consumption, less contamination and higher efficiency, learn to recognize the value of these five rings.

2. To cut maintenance costs, railroads are switching to "roller freight." You'll find tapered roller bearings in all Worthington compressors. Not only do they provide lower friction load, but they also can be adjusted to compensate for wear. To get the best make sure you always specify compressors with "adjustable tapered roller bearings."

3. When operating, the valve strip shown above opens and closes with a gentle rolling contact – there's no destructive impact. Replacement is infrequent and unlike many other makes which require replacement of the complete cylinder or head, all Worthington compressors are equipped with individually replaceable valves, valve guards, and valve seats. This feature saves many maintenance dollars.

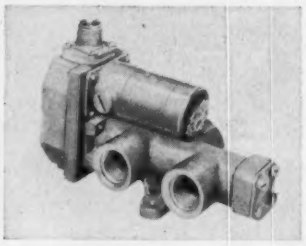
4. Developed by Van Zelm Associates of Baltimore, the Navy's new mobile catapult is "fired" by compressed air supplied by a 20-hp Worthington compressor. As true in industry as it is in defense whenever men need reliable compressed air they turn to the company with a reputation for performance. Worthington Corporation, Harrison, New Jersey.

PG. 7.13

WORTHINGTON

Circle 518 on page 19

New Parts



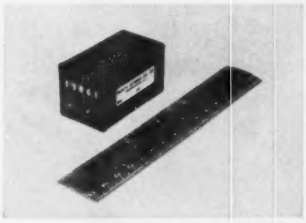
requirements of MIL-V-5529A and MIL-E-5272A. It operates through ambient temperatures of − 65 to 160 F. **Lyndon Aircraft Inc.**, 140-55 Clifford St., Newark, N. J.

Circle 702 on page 19

Elapsed-Time Indicator

is miniature, lightweight unit

Miniature elapsed-time indicator is designed for use in airborne or ground equipment in applications such as radar sets, computers, and navigation systems. Low-speed synchronous motor and gear train arrangement provides a 14,400:1 ratio while utilizing only four gears. Unit is 1¼ x 2¼ in. in size and weighs 4 oz. Time range is 9999.9 hr indicated on five count-



er wheels. Power consumption is 3.5 w at 26 or 115 v ac, 400 cps. Unit meets environmental conditions of MIL-E-5272A. **Magnetic Instrument Mfg. Corp.**, 546 Commerce St., Thornwood, N. Y.

Circle 703 on page 19

Quick-Disconnect Connectors

for aircraft use

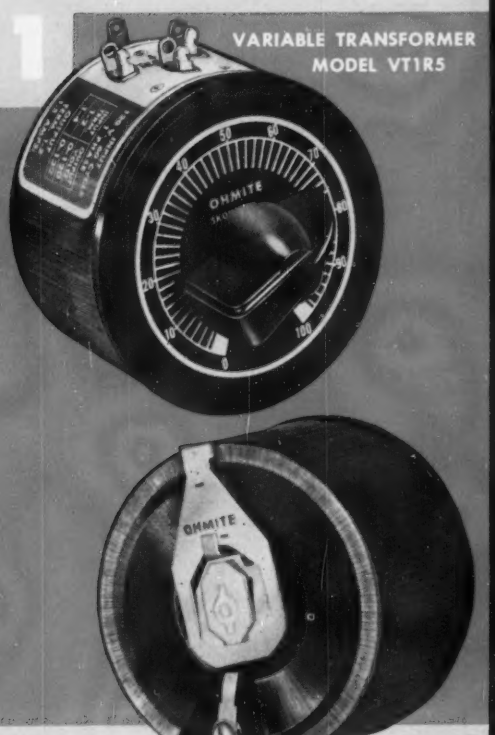
Q-series quick-disconnect connectors have environmental-resistant features which make them adaptable for aircraft usage. Three sizes with three shell configurations for each size are available: Square-flanged receptacle for wall mounting; hermetically sealed round-flange receptable; and a straight plug. All external parts are cadmium-plated aluminum al-

Circle 519 on page 19

2 new components from OHMITE®

subminiature wire-type tantalum capacitors and variable transformer

1 VARIABLE TRANSFORMER MODEL VT1R5



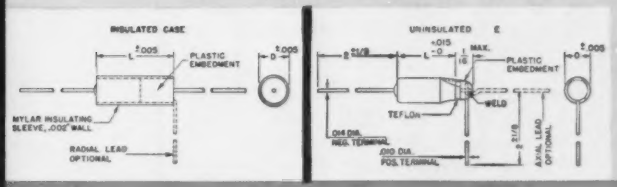
MORE CAPACITY FOR EQUAL SIZE

The rating of 1½ amperes represents a continuous rating at any brush setting. This "bonus" in current capacity is the result of a unique core design by Ohmite. The new Ohmite VARIABLE TRANSFORMER model VT1R5 features: Long-wearing, nonoxidizing, rhodium-plated coil contact surface, a ceramic hub that mounts the contact arm, and provides 3000 VAC insulation between parts at line potential and shaft assembly; positive brush to center-lead connection because brush pigtail shunt is bonded into solid copper-graphite slip ring. Input voltage is 120 V, 60 cycle; output voltage is 0-120 V—0-132 V. Mounted by ⅜"-32" bushing and nut. *Write for Bulletin 151.*

2 TANTALUM CAPACITORS SERIES TW

GREATER CAPACITANCE PER UNIT VOLUME

The new Series TW Ohmite subminiature Tan-O-Mite® TANTALUM CAPACITORS are wire-type units that feature greater capacitance per unit volume, lower leakage current and power factor, and small capacitance drop at extremely low temperatures as compared to other types of electrolytics. Ultrasmall for low-voltage DC transistorized electronic equipment, these new tantalum capacitors have *high stability, high capacitance, long shelf life,* and excellent performance under temperature extremes of −55° C to +85° C. They are available in six *subminiature sizes:* 0.1 to 60 mfd. over-all capacitance range.



SIZE	UNINSULATED		INSULATED	
	D (inches)	L (inches)	D	L
T	.075 (5/64)	.156 (5/32)	.082	.203
S	.075 (5/64)	.187 (3/16)	.082	.234
M	.095 (3/32)	.172 (11/64)	.100	.218
A	.095 (3/32)	.250 (1/4)	.100	.312
B	.125 (1/8)	.312 (5/16)	.134	.375
C	.125 (1/8)	.500 (1/2)	.134	.562

Smallest size is .075 (5/64) x .156 (5/32) inches; the largest is .125 (1/8) x .500 (1/2) inches. Five stock sizes are available in a wide range of capacitances, voltages. Units insulated with a tough Mylar® plastic sleeve can be furnished. *Write on company letterhead for Bulletin 148B.*

BE RIGHT WITH

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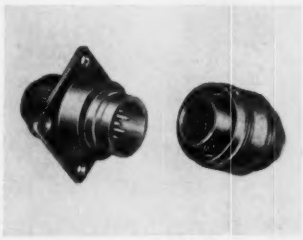
RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES
TANTALUM CAPACITORS • VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY
3618 Howard Street, Skokie, Illinois

Circle 520 on page 19

New Parts



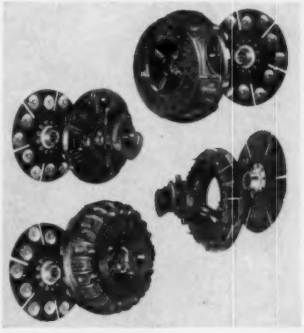
loy. Contacts are silver-plated brass. Contact rating is 10 amp for No. 18 AWG wire. **Cannon Electric Co.**, P. O. Box 3765, Terminal Annex, Los Angeles 54, Calif.

Circle 704 on page 19

Clutches

for heavy-duty applications

Morlife clutches use friction material with ceramic base to provide increased capacity, better heat disposal and ventilation, cooler running, no fading, longer wear, fewer adjustments and more usable lining material. Clutches, for heavy-duty use in tractors, trucks and road-building machines, are



available in over-center and spring-loaded types in sizes to 18 in., single and double plate. **Borg-Warner Corp.**, Rockford Clutch Div., 1301 18th Ave., Rockford, Ill.

Circle 705 on page 19

Potentiometer

is all-metal, multiturn unit

Type 909 precision ⅞-in. diam multiturn potentiometer is available with mechanical rotation of 3 to 20 turns per cup. It provides low noise, excellent shock and vibration characteristics, good linearity, and is available in standard or

Circle 521 on page 19

Circle 522 on page 19→

NEW GENERAL ELECTRIC DC MOTOR GIVES

Instant Working Power

KINAMATIC* . . . a new standard in industrial direct current motors . . . designed to deliver drive power at the moment you need it!

Split-Second Response . . . larger air gaps reduce electrical time constants . . . smaller armature diameter permits more rapid delivery of torque to load . . . means faster starts, stops, reversals.

Low Inertia Armature is dynamically balanced, banded with steel and glass . . . gives dependable, high-speed operation . . . skewed armature slots minimize torque pulsation, permit smooth machine operation at low speed.

Other Power Packed Features of new d-c Kinamatic motors help give you more continuous, more automatic production . . . economically.

Additional information is available at your nearest General Electric Apparatus Sales Office. Or, if you prefer, write for Bulletin GEA-6355. *Direct Current Motor and Generator Department, Erie, Pennsylvania.* 813-9

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cosponsored by Purdue University and *Machine Design*

OCTOBER 14-15, 1957 • Lafayette, Indiana • PURDUE UNIVERSITY

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PROGRAM

Session 1

MECHANISM DESIGN IN GERMANY
Kurt Hain, Kinematic Research Scientist, Braunschweig, Germany

Session 2A

CAM-FOLLOWER EQUIVALENT MECHANISMS
Prof. Harold A. Rothbart, The City College of New York

DESIGN OF A CONSTANT-LOAD CAM
John A. Carlson, Product Development, Teletype Corp.

A HIGH-SPEED INDEXING MECHANISM
Ray C. Johnson, Senior Design Engineer, Eastman Kodak Co.

Session 2B

KINEMATIC SYNTHESIS VIA COMPLEX NUMBERS
Prof. Richard S. Hartenberg, Northwestern Univ.

KINEMATIC ANALYSIS VIA COMPLEX NUMBERS
Prof. G. H. Martin, Michigan State Univ.

ALTERNATE FOUR-BAR MECHANISMS
Prof. A. S. Hall Jr., Purdue Univ.

Banquet

UNLOCKING HUMAN CREATIVITY
Dr. Richard W. Wallen, Senior Associate, Creelman Associates, Cleveland, O.

Session 3

ANTICIPATING DYNAMIC BEHAVIOR
Prof. J. B. Hartman, Lehigh Univ.

PREDICTING IMPACT FORCES
Ray C. Johnson, Senior Design Engineer, Eastman Kodak Co.

LINKAGES USING RACKS AND PINIONS
Erwin P. Pollitt, Senior Research Engineer, Armour Research Foundation

Session 4

THE DOUBLE-CRANK LINKAGE
Kurt Hain, Kinematic Research Scientist, Braunschweig, Germany

DWELL LINKAGES VS. CAMS
Prof. Thomas P. Goodman, Massachusetts Institute of Technology

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The following persons plan to attend the Mechanisms Conference, October 14 and 15, 1957 (name and title, please):

Fee enclosed

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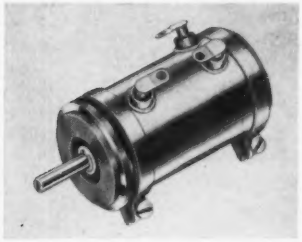
$_____ is enclosed for the registrations checked at $25 each. (Make checks payable to Purdue University.)

☐ Fees will be paid at registration time.

Name _____

Company _____

Address _____



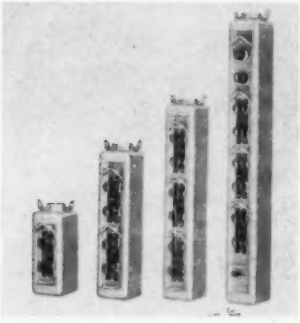
high-temperature types. Stainless steel is used for the case and major structural components. Metal-to-glass terminals are welded to the case. Resistance range is 100 to 200,000 ohms for a ten-turn unit. Standard linearity is 0.5 per cent. **Fairchild Controls Corp.,** Components Div., 225 Park Ave., Hicksville, N. Y.

Circle 706 on page 19

Pushbutton Stations

for heavy-duty applications

Cam-operated pushbutton stations are rated 600 v ac or dc. They are available with from one to five speed-points in each direction. Total of eight circuits provides for many different sequences of operation in heavy-duty applications. Steel shrouds guard large operating buttons. Removable glass fiber



rear cover affords quick inspection of silver-to-silver contacts without disturbing wiring. **Euclid Electric & Mfg. Co.,** 54 Edwards St., Madison, Ohio.

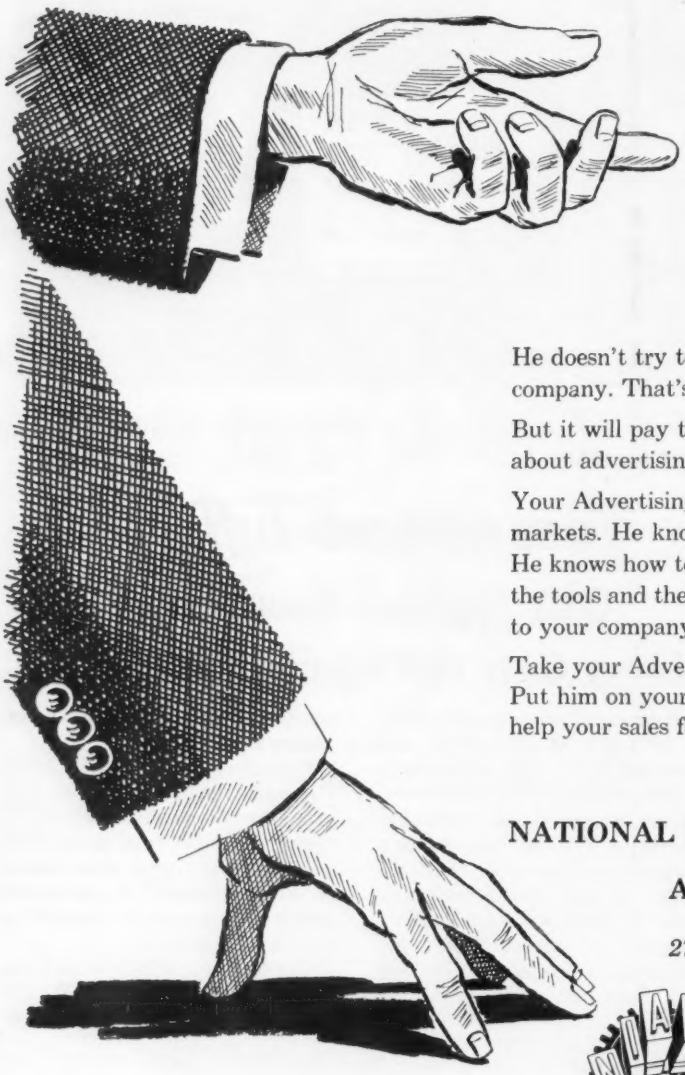
Circle 707 on page 19

Fuel Transfer Pump

has 60 gph sea-level rating

Model RG16140 reversible fuel transfer pump consists of positive-displacement rotary vane pump, exposionproof electric motor, and

Does your Board of Directors listen to this man?



He doesn't try to tell your Directors how to run the company. That's their job, and he respects it.

But it will pay them to listen to him when he talks about advertising for your company. That's his job!

Your Advertising Manager is a man who knows markets. He knows the science of "mechanized selling." He knows how to help turn sales goals into sales. He has the tools and the know-how to make major contributions to your company's progress and profit.

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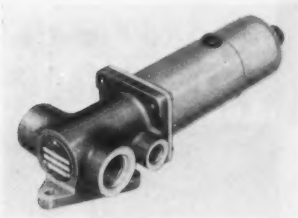
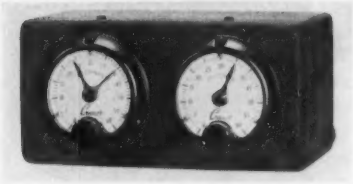


radio noise filter. It is designed to pump several types of aviation fuels. Pump has sea-level rating of 60 gph with 5 psi gage discharge pressure; rating at 15,000 ft is 50 gph with 5 psi gage discharge pressure. Continuous-duty 0.036-hp motor operates on 27 v dc and has maximum current drain of 1.5 amp at rated conditions. Internal wiring to electrical connector provides for reversing direction of rotation through external switch connections. Built-in radio noise filter meets requirements of MIL-L-6181B. **Lear Inc.**, Lear-Romec Div., Elyria, Ohio.

Circle 708 on page 19

Duplex Cycling Timer

utilizes two standard motor-driven timers



Type 742 timer controls operation of process work equipment, regulates both idle and operating time on a wide variety of production machinery, or performs a number of functions automatically. It utilizes two standard motor-driven automatic reset timers. Each timer operates in turn, providing a timed interval, restarting the other at the conclusion of each timed period, then resetting instantly for next cycle. Each load switch is operated within repeat accuracy of ¼ per cent of full scale and is rated at 15 amp, 125 v noninductive. Adjustment on each timer is independent of the other. Eleven time ranges permit more than 60 combinations. **Cramer Controls Corp.**, Centerbrook, Conn.

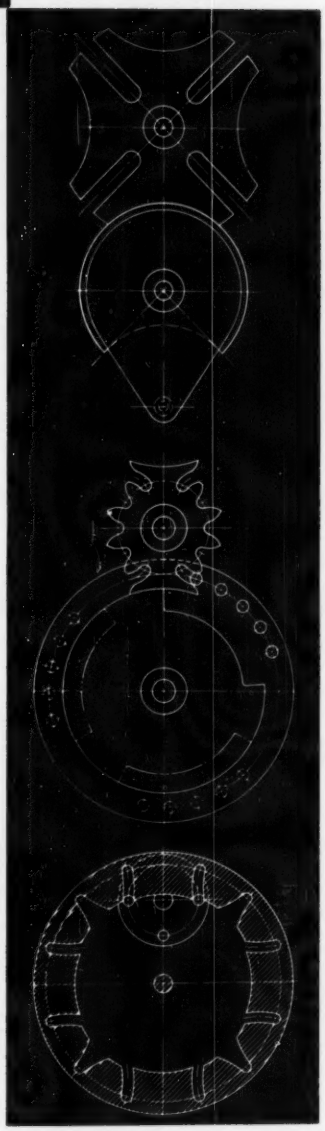
Circle 709 on page 19

again available in reprint • • • •

"MECHANISMS FOR INTERMITTENT MOTION"

by Otto Lichtwitz

A SYSTEMATIC TREATMENT OF THE PROBLEMS INVOLVED FOR IMPARTING INTERMITTENT MOTION THROUGH EXTERNAL AND INTERNAL GENEVA AND STAR WHEELS, AND INTERMITTENT MECHANISMS FOR INTERSECTING AND CROSSING SHAFTS



In the December 1951, and January, February and March 1952 Issues, MACHINE DESIGN published what has proved to be an enormously successful series of articles on "Mechanisms for Intermittent Motion". Mr. Lichtwitz' approach to the subject of intermittent motion is systematic and extremely well organized. The tables provided to reduce time and effort in making detailed calculations are themselves invaluable.

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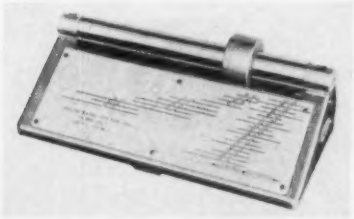
ENGINEERING DEPARTMENT

EQUIPMENT

Limits and Fits Unit

demonstrates fit between shaft and hole

Demonstration unit provides the actual feel of a fit between shafts and holes of matching cylindrical parts. It consists of a tapered bar of approximately 1 in. in diameter



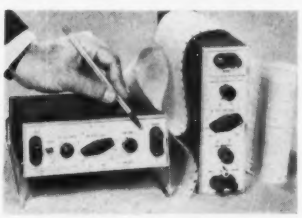
and a sliding reference ring with bore of same taper, providing a parallel clearance between ring and shaft. Scale, mounted in front of bar and protected by a clear plastic cover, is divided vertically to represent specified clearances and horizontally to represent minimum and maximum clearance for a number of preferred fits in diameter range. Scales are available for American and Canadian standards, as well as international standards. **Engis Equipment Co.**, 431 S. Dearborn St., Chicago 5, Ill.

Circle 710 on page 19

DC Amplifier

is transistorized and electronically modulated

DC amplifier for use with milliammeter recorders is fully transistorized and electronically modulated. Designated Model 301, it has sensitivity from 10 mv dc to



Circle 525 on page 19

Engineering Equipment

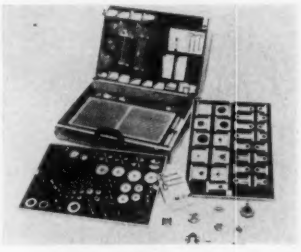
100 v dc full scale in 12 ranges. Frequency response is up to 50 cps. Amplifier operates from line voltage or self-contained battery. Modulation is unaffected by variations in line voltage. Absolute accuracy is 2 per cent of full scale. **Texas Instruments Inc.**, 3609 Buffalo Speedway, Houston 6, Tex.

Circle 711 on page 19

Breadboard Kit

contains miniature mechanical components

For use in research and development projects, Type D kit contains over 650 mechanical compo-



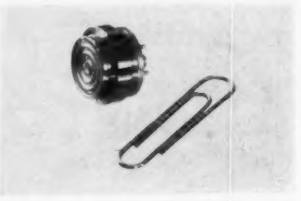
nents, such as gears, shafts, collars, and differentials. Kit enables the use of ⅛-in. bore gears of 96 pitch. **PIC Design Corp.**, 477 Atlantic Ave., East Rockaway, N. Y.

Circle 712 on page 19

Pressure Transducer

is miniature, high-output unit

Flange-mounted Dynisco pressure transducer is useful in missile, airplane, wind tunnel, chemical or atomic research where transducers combining small size, high output and accuracy are required. Output varies from 25 to 100 mv full scale, depending on pressure range. Total weight of unit is 7 grams. It can be mounted flush with inner surface of pressure chamber to measure fast pressure variations. Accuracy of ±0.5 per cent full scale



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Multiple-Circuit Switches

lever – rotary – push or pull

A design manual on the factors to be considered in the selection and application of multiple-circuit switches.

Part One—discusses physical and electrical characteristics of lever-operated switches

Part Two—discusses physical and electrical characteristics of rotary switches

Part Three—discusses physical and electrical characteristics of push or pull switches

Part Four—discusses factors to be considered when selecting switches from these types for a specific application

---

How to select and apply

Electrical Connectors

Separable electrical connectors can often help satisfy several design objectives—convenience, portability or mobility, flexibility. Connectors provide these features in two kinds of circuits—power and signal.

Part One—discusses how to select and apply Electrical Connectors for power circuits

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TITLE _____

COMPANY _____

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CITY _____ ZONE ____ STATE _____

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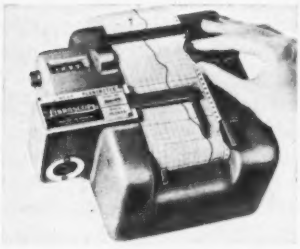
is possible with use of four-active-arm strain-gage sensing element. Unit operates in temperatures from −100 to 300 F. **Dynamic Instrument Co.,** 28 Carleton St., Cambridge 42, Mass.

Circle 713 on page 19

Analog Computer

integrates linear strip-chart data

Model 601 linear Planimeter is a small, desk-size analog computer which is used for integrating linear strip-chart data. Designed to accept chart sizes to 3 7/16 in.,



unit incorporates a variable-speed, foot-control drive. It handles 2 ft of chart in 15 seconds with optimum accuracy of 0.1 per cent. **Librascope Inc.,** 808 Western Ave., Glendale, Calif.

Circle 714 on page 19

Strain Gages

foil-type units have superior characteristics

Foil-type SR-4 strain gages provide fatigue life, sensitivity, and hysteresis characteristics superior to those of bonded-wire SR-4 units. New gages extend useful room-temperature range to 300 F for continuous duty and 400 F for short-time measurements. Thin and flexible, the gages are easily applied, especially in fillets. They are free from internal solder joints and have low cross-sensitivity to strain. Type FAP-2 is a quick-drying, paper-and-cement bonded gage, and type FAB-2 is a Bakelite-bonded unit. At strain levels of ±3000 mu in. per in. the gages show negligible hysteresis. **Baldwin - Lima - Hamilton Corp.,** Electronics and Instrumentation Div., Dept. SO 82, 42 Fourth St., Waltham, Mass.

Circle 715 on page 19

Circle 528 on page 19

THE ENGINEER'S Library

Recent Books

Fasteners Handbook. *By Julius Soled; 430 pages, 6 by 9 in., clothbound; published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.; available from* MACHINE DESIGN, $12.50 *postpaid.*

This handbook provides a comprehensive coverage of fasteners and fastener problems. Contents have been selected and classified especially for design engineers and others interested in industrial fasteners.

Arrangement of material permits selection of fasteners for particular applications. Included are illustrations, standards, materials specifications, sizes, description, and manufacturers of each type of fastener. The book presents detailed information on all currently available fasteners, both standard and proprietary; many specialized fasteners developed since World War II; and specific fasteners that increase structural safety and reliability.

This reference also relates actual uses of fasteners in one industry to those of another, and includes examples of economical application.

Certain selected portions of the Fasteners Handbook appeared in condensed form in MACHINE DESIGN, Aug. 23, 1956, as "Design Guide to Industrial Fasteners."

Thermal Stresses. *By B. E. Gatewood, Air Force Institute of Technology, Wright-Patterson Air Force Base; 232 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, $7.50 *postpaid.*

This book covers all phases of design problems at elevated temperatures. Emphasis is on fundamental theory, and treatment is applicable to many types of machines including aircraft, nuclear

reactors, rocket motors, steam and gas turbines, and missile airframes.

Topics include temperature distribution, elastic and inelastic thermal stresses, combined applied and thermal stresses, allowable stresses of various materials, and buckling, deflection, stiffness, fatigue, shock, and flutter effects of elevated temperatures. Also included are general procedures for solving thermal-stress equations in two dimensions.

Glass Reinforced Plastics. *Edited by Philip Morgan; 276 pages, 6 by 9 in., clothbound; published by Philosophical Library Inc., 15 East 40th St., New York 16, N. Y.; available from* MACHINE DESIGN, *$15.00 postpaid.*

This second edition has been completely revised to incorporate latest developments in glass reinforced plastics since 1954. New chapters on epoxide-glass combinations and application of glass-reinforced materials have been added. In addition, an automatic resin injection system of molding is dealt with separately.

Polyesters are treated more fully than other resins. Techniques included are standard commercial molding processes, methods of mass production, resin injection, and manufacture of tube and rod. Major fields of application described are automotive, aviation, electrical and chemical plants.

Bearing Design and Application. *By Donald F. Wilcock and E. Richard Booser, General Electric Co.; 464 pages, 6 by 9 in., clothbound; McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$12.50 postpaid.*

This guidebook for machine designers is intended as an aid in selecting and designing bearings. Emphasis is on selection and calculation methods for integrating bearing design, material, and lubrication into a workable unit.

Subjects covered are analysis of load capacity, speed, temperature, dimensional tolerances, lubrication factors in selecting ball and roller

Circle 530 on page 19

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bearings, digital computer analysis, reciprocating bearing design methods for automotive and diesel use, and lubrication system designs. Also included are systematic trouble-shooting techniques.

Mechanical Engineering Research, 1956. *67 pages, 6 by 9½ in., paperbound; available from British Information Services, 45 Rockefeller Plaza, New York 20, N. Y.; 77 cents per copy.*

This book contains a report on proceedings of the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow. MERL carries out fundamental and applied research on many aspects of mechanical engineering. Investigations for 1956 covered studies of fatigue cracks, strength of pin-joints, flow measurement, cavitation, boundary friction, fractional-horsepower dynamometers, design of dies, applied thermodynamics, and heat transfer.

Additional information on mechanical engineering problems is available from the Laboratory.

Association Publications

Digest of the Literature on Dielectrics. *Edited by R. W. Crowe and J. D. Hoffman; 236 pages, 8½ by 11 in., paperbound; published by and available from National Academy of Sciences, National Research Council, 2101 Constitution Ave., Washington 25, D. C.; $5.00 per copy.*

This nineteenth volume of the Digest covers items from scientific periodicals, books and theses published during 1955. Three major sections are concerned with instrumentation and measurement techniques, dielectric phenomena from the molecular viewpoint, and reports on electrical insulation with emphasis on applications and materials.

Other topics include measurements with nonsinusoidal waveforms, resonance methods, dielectric constants, dipole moments, ionic interaction in dielectrics, conduction phenomena, ferroelectric materials, ferromagnetic materials, rubber and plastic insulation, and insulating films and liquids.

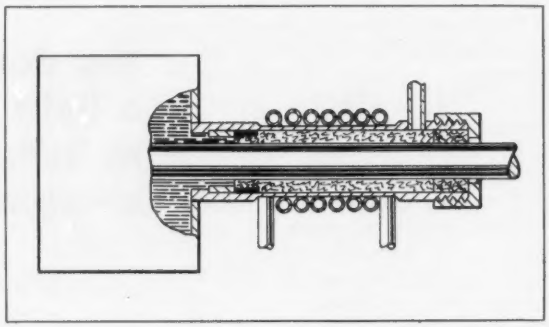
Circle 531 on page 19

NOTEWORTHY

Patents

Shaft Seal

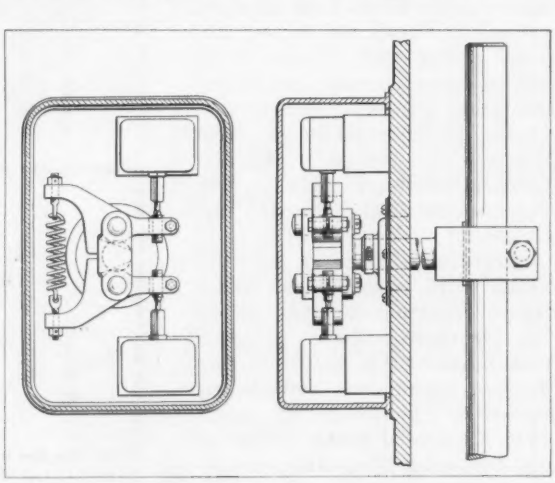
Pressurized molten metals with low melting points —for example, sodium or potassium—are prevented from leaking around a rotating shaft by a metal-wool-packed sealing assembly. Molten material is allowed



to saturate the wool and is frozen or solidified by an external cooling coil to form a close-fitting sealing bushing. Wool, which is preferably of stainless steel, is wrapped with wire at its inner end to prevent it from working into the container. Shaft can be stopped for a considerable length of time and restarted with minimum break-away torque. *Patent 2,799,522 assigned to Mine Safety Appliances Co. by Earle C. King and Verne K. Heckel.*

Switch-Operating Mechanism

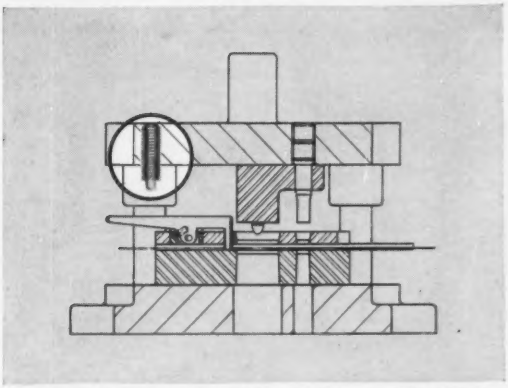
Lost motion is at a minimum in a sensitive, quick-acting switch mechanism. Bell cranks, which are pin-mounted to a T-head on the translating actuating arm, rotate and actuate one of the two snap-action switches when the actuating arm, shown



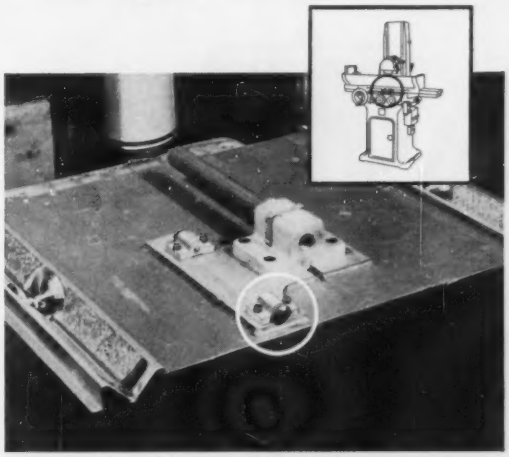
Practical Design Tips

Number 2 of a series.

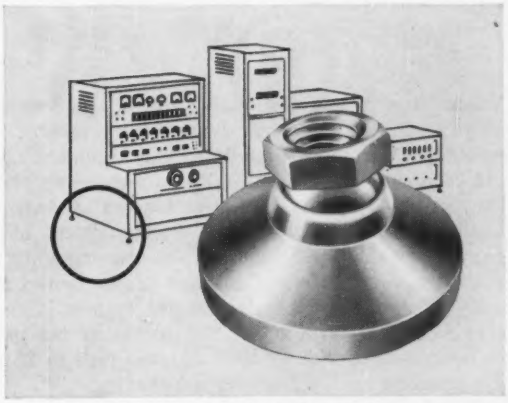
Substituting simple, off-the-shelf Vlier Tooling Accessories for complicated, custom-made devices in both tooling and original equipment applications can result in important savings. Why not put them to work in your plant?



TO STOP SMASHING DIE STOPS, substitute a Vlier Spring Plunger for the usual square-head screw. The plunger actuates the automatic stop perfectly and, unlike the screw, never needs adjusting no matter how many times the die is resharpened. Available in four models: 50 sizes.



TO CUSHION SHOCK as the bed traverses, this surface grinder manufacturer uses two Vlier Spring Stops, reducing wear and tear on the machine. These clever, spring-loaded devices, ordinarily used on fixtures where the absence of side walls prevents the use of spring plungers, are now available in three standard sizes: 3 end pressures. Special sizes made to quantity orders.



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VLIER ENGINEERING INCORPORATED

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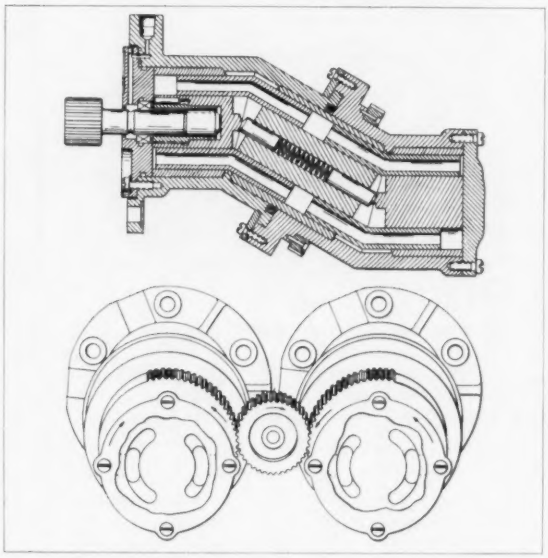
Circle 533 on page 19

Noteworthy Patents

clamped to a push rod, moves longitudinally. Tension spring holds bell cranks against integral stops (not shown). *Patent 2,799,172 assigned to Taylor-Wilson Mfg. Co. by William M. McConnell and John R. Von Hofen.*

Adjustable-Volume Pump

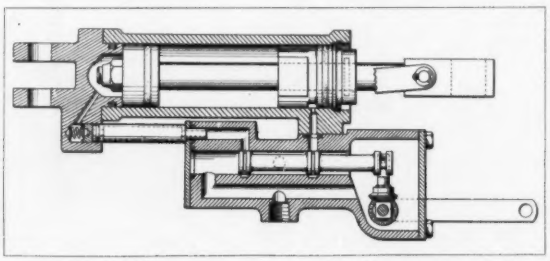
Tandem or end-to-end mounting of multiple-piston hydraulic-pump sections permits the volumetric flow to be changed by varying the angle of the pump-axis



intersection. Upper view shows angle of axes at minimum flow rate. When movable pump section (opposite drive end) is rotated 180 deg around the parting face, the phase relation of corresponding pistons then gives maximum flow rate for the tandem unit. Lower view shows side-by-side arrangement of two such adjustable-volume pumps. Pinion engaging ring gears rotates pump housings and can be driven manually, or by an automatic control system. Side-by-side mounting permits reaction torque of the pumps to be cancelled. *Patent 2,800,082 assigned to Thompson Products Inc. by Leslie L. Aspelin.*

Follow-Up Valve

Hydraulic follow-up mechanism combines a piston and cylinder assembly (top) with a manually actuated valve (bottom). Signal feedback from the piston

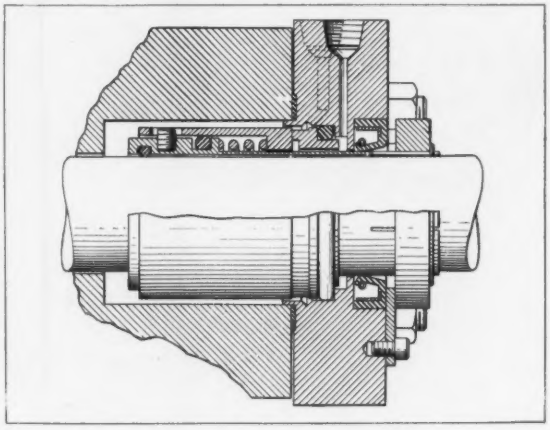


Noteworthy Patents

rod to the valve is through a mechanical linkage not shown here. Movement of the piston stops after it has traveled a distance proportional to the input rotation of the primary control arm (bottom right). Control arm can be moved to a new position without waiting for the motor piston to complete its action. *Patent* 2,799,250 *assigned to Bendix Aviation Corp. by Carlos B. Livers.*

Mechanical Seal

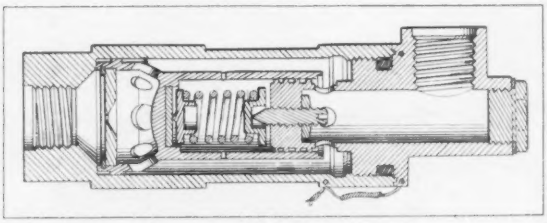
Externally mounted spacer fingers, temporarily positioned during seal installation between the gland-plate face and the seal-sleeve clamping collar, help



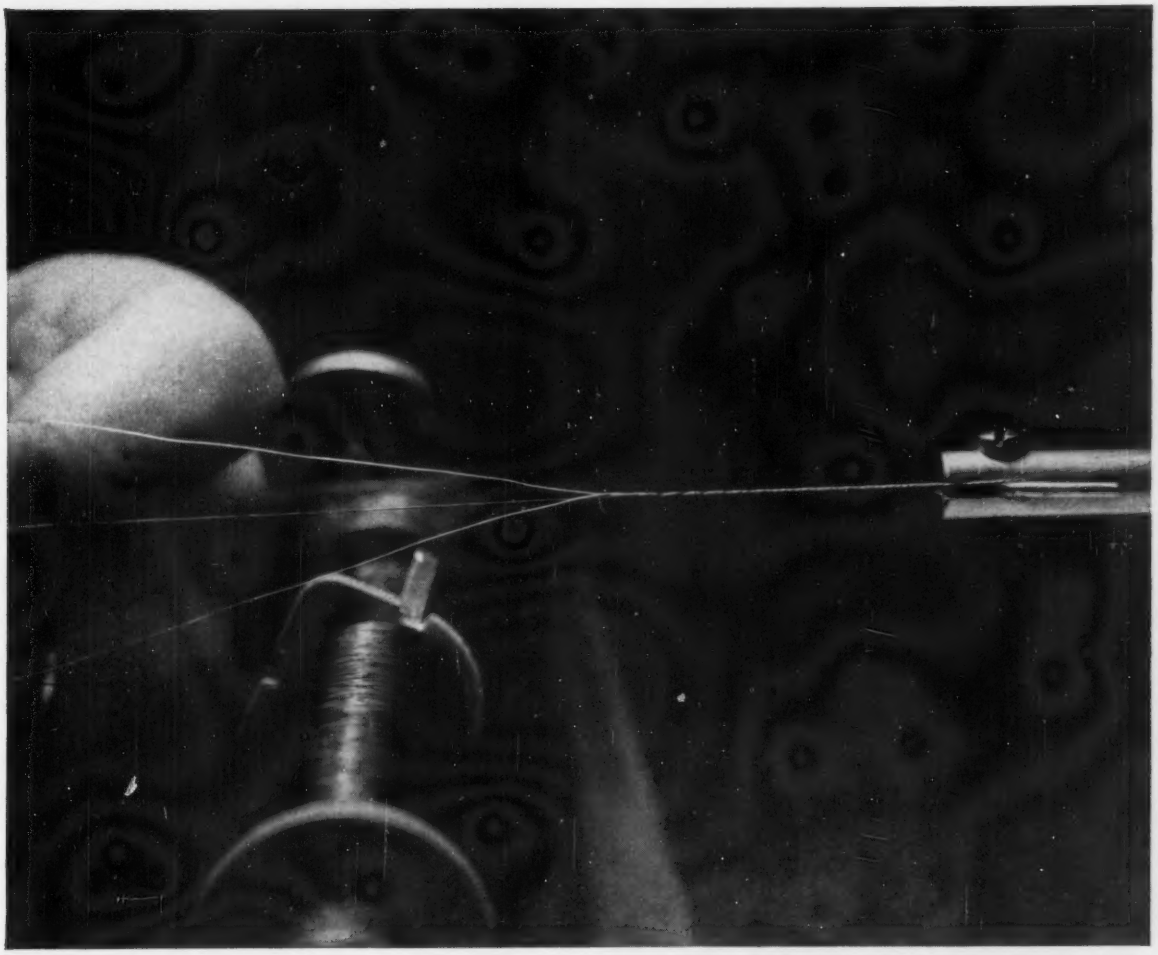
set optimum sealing-face pressure in a mechanical shaft seal. After insertion of the seal assembly within the housing recess, spacers are swung into position and the clamping collar is tightened. This establishes the manufacturer's recommended sealing-face spring tension. Spacer fingers, which are screw-mounted on the gland face, are then rotated out of the way to an inactive position. *Patent* 2,797,940 *assigned to Garlock Packing Co. by Herbert E. Michener and James R. Smith.*

Flow Regulator

Flow is reversed at the throttling ports in a flow-regulating valve, holding flow volume constant despite substantial variations in fluid inlet pressure.



Fluid passes from valve inlet (right), through annular passage separating housing ID and throttling-piston skirt, and then returns by way of the throttling ports to the central bore communicating with the outlet connection (left). Variable-throttling



Solderless splice solves problem of open coil windings

STANDARDS THAT DETERMINE RELAY QUALITY/

trouble-free coil windings

Solderless splice ends failures two ways

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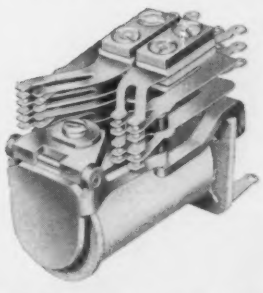
Because we make terminal connections over a long section of stranded wire, electrolysis has no single point to attack. And this flexible connection will never snap under temperature extremes or other stress-producing factors.

In every step of relay design and manufacture, we take extra pains to prevent trouble before it starts.



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A member of the General Telephone System
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GENERAL SYSTEM

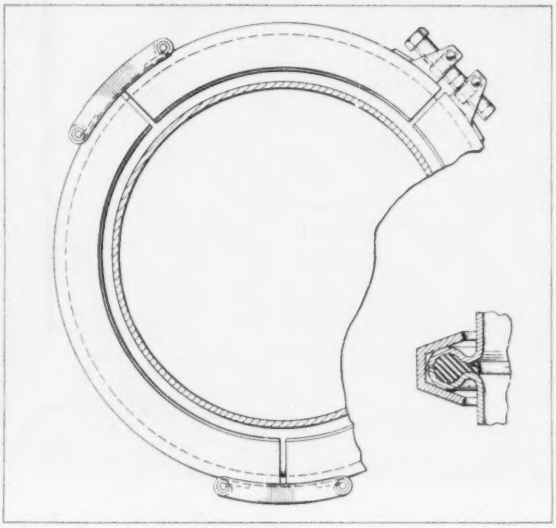
Circle 537 on page 19

Noteworthy Patents

action, giving constant flow rate, is effected by axial movement of the piston skirt against the regulator spring. Stepped construction of the down stream end of the piston skirt forces fluid to reverse when passing throttling ports, thereby counterbalancing the reduced static pressure with the impact pressure of the fluid striking the step. *Patent* 2,800,141 *assigned to William Waterman by Harry A. Hedland.*

Sealing-Ring Assembly

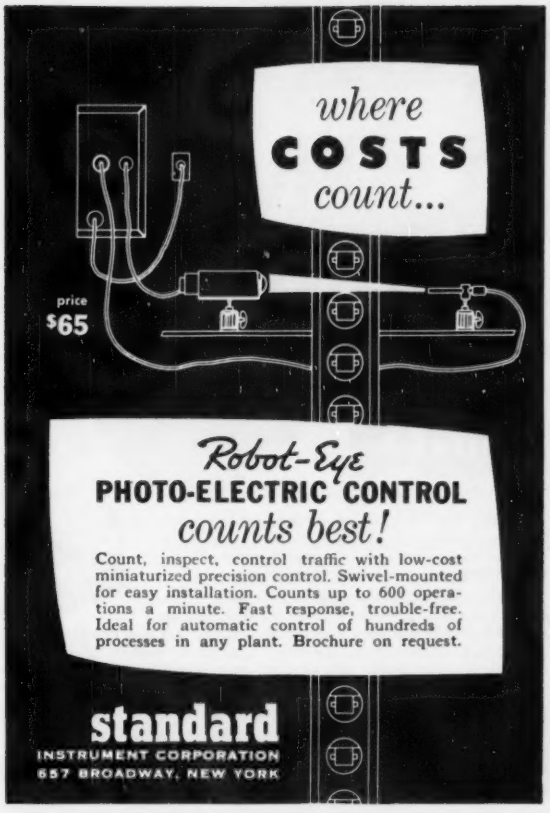
Adjacent parts of a pressure vessel—an oil-filter housing and its cover, for example—are efficiently sealed by a multiple-segment sealing-ring assembly. Tightened by a screw-clamp arrangement, individual



ring segments are flexibly linked at butt ends so as to minimize distortion during assembly. Elastic sealing ring, seated in flanges formed in the pressure-vessel ends, provides sealing action when segmented ring is drawn tight. *Patent* 2,801,764 *assigned to Luber-Finer Inc. by John K. Russell and Walter W. Boggs.*

Silver bearing material, constituting an electrodeposited silver layer protected by 0.0003-in. indium layer, resists the corrosive action of sulphur in lubricating oils. Indium, which is diffused into the silver by a heat-treating process, protects the silver against scratching, scoring, or excessive wear. For heavy-duty applications, an overlay of lead-indium or lead-tin is deposited over the silver-indium bearing surface. Backing for the bearing layer, usually a hard metal such as steel, is flashed with a layer of copper prior to deposition of silver. *Patent* 2,765,520 *assigned to General Motors Corp. by Carson O. Donley.*

Copies of patents briefed in this department may be obtained for 25 cents each from The Commissioner of Patents, Washington 25, D. C.



Circle 539 on page 19

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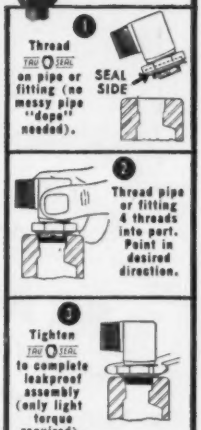

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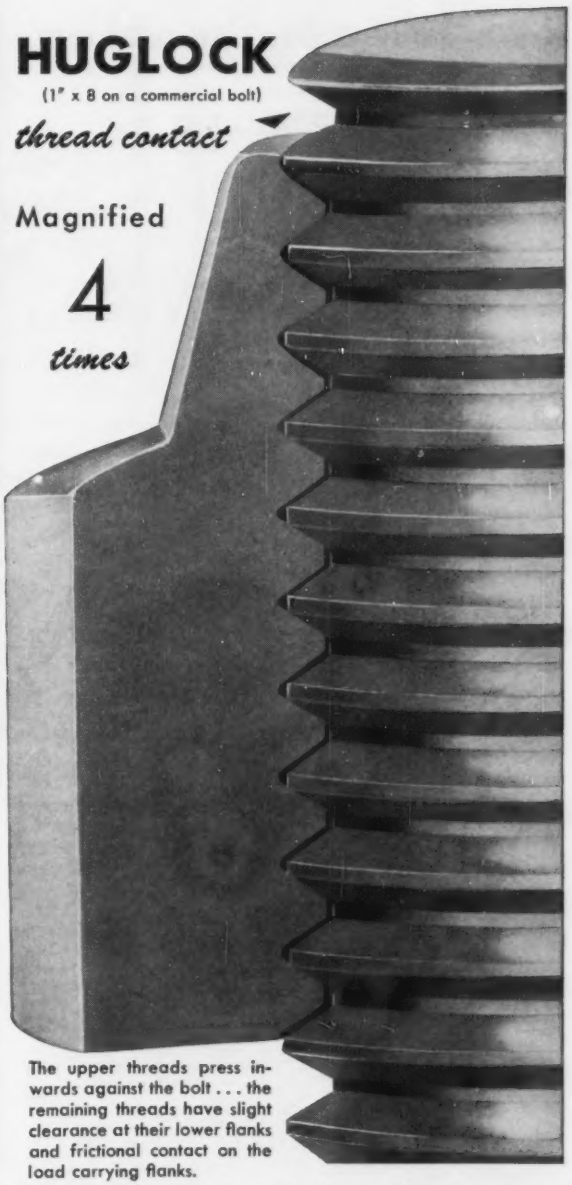

The upper threads press inwards against the bolt . . . the remaining threads have slight clearance at their lower flanks and frictional contact on the load carrying flanks.

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Circle 541 on page 19

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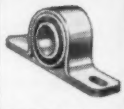

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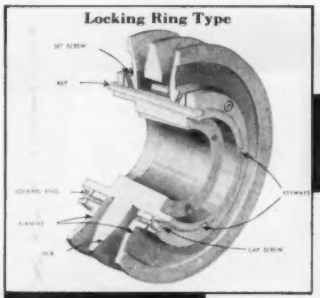

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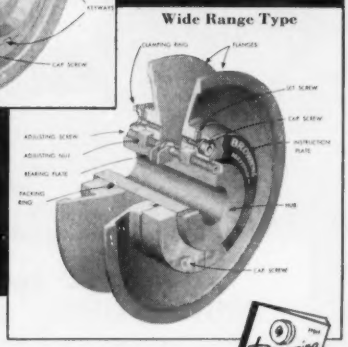

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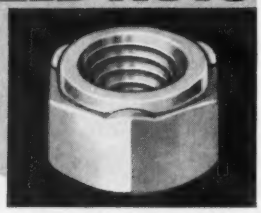
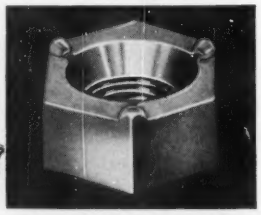
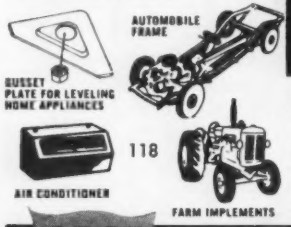


Gripco Pilot-Projection Weld Nut, circular pilot designed, provides quick, easy positioning of nut in bolt hole for instant resistant welding. No jigs, no fumbling, no waste of time. Weld spatter cannot foul threads. Two pilot heights for different metal gauges.



Gripco Countersunk Weld Nut eliminates time-wasting retapping of nuts after welding. Exclusive countersunk nut bottom eliminates fouling of threads by weld spatter. No time wasting false starts, no cleaning of damaged threads, nut ready to receive bolt immediately.



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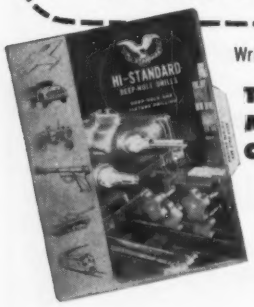

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Circle 552 on page 19

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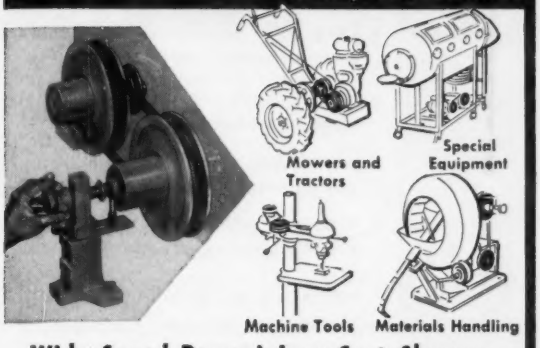

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- In Line Flow

The ARROW LUBRICATOR

- Mist Lubrication
- Mist Proportional to Air Flow
- Lubricates Only When Equipment is in Operation

The ARROW DRAIN TRAP

- Fully Automatic
- Operates Independent of Pressure
- Double Sump Action to Protect Valve

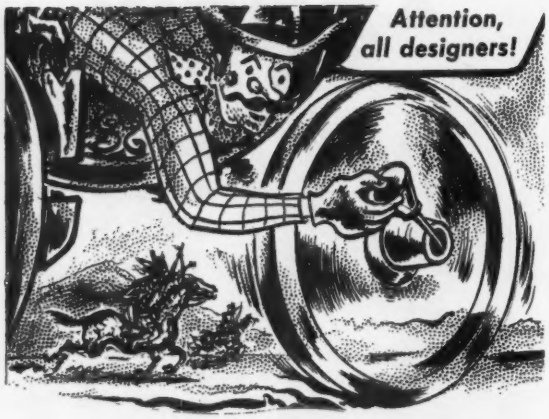
QUALITY PRODUCTS SINCE 1914

Catalog and engineering data on request.

ARROW TOOLS, INC.

1918 S. KOSTNER AVE. • CHICAGO 23, ILL.

Circle 554 on page 19



TROUBLE-FREE BEARINGS

...where it counts the most!

KARAK is a mixture of graphite and other forms of carbon. Self-lubricating, it solves bearing lube problems many times, many ways. It provides freedom of design for the inaccessible bearing. Adaptable grades meet varying factors of speed, load, temperature, pressure, and material to be handled. Unlike metals, it will not melt or seize. It will not distort under heat. Results are greatly extended bearing life and reduced maintenance.

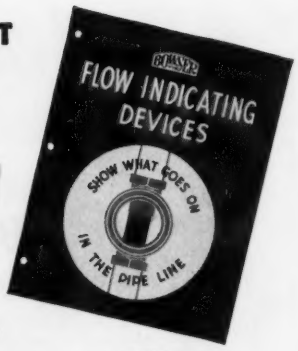
Write factory today for free sample KARAK bearing, and information sheets No. 1164-74.

The OHIO CARBON COMPANY

12508 Berea Road, Dept. 281, Cleveland 11, Ohio

Circle 555 on page 19

THIS BOOKLET "FLOW INDICATING DEVICES" IS YOURS



... CONTAINS DATA ON WIDE SELECTION OF FLOW DEVICES SUCH AS:

Fig. 54A Flow Sight — Fig. 816 Teleflo Indicator — Fig. 811 Flow Indicator

Plant and product engineers have relied on Bowser, liquid handling specialists since 1885, for prompt service. For sight glasses in single or double-window types, gravity or pressure models; or for electric or mechanical indicators ... there is a Bowser man nearby ready to help you ... quick!

PRODUCT OF BOWSER RESEARCH

WRITE FOR FLOW DEVICES BOOKLET } ***Contains Complete Specifications***

BOWSER, INC., 1314 E. CREIGHTON, FT. WAYNE, IND.

Circle 556 on page 19

1001 USES FOR HARDWARE

Whether you make tool boxes or locomotives, Stanley's Industrial Hardware Department is set up solely for your benefit.

Thousands of original equipment manufacturers already call on our unequalled design and production facilities to help make their products function more efficiently.

Let Stanley help you. Send for our industrial brochure, "At Your Service." Stanley Hardware, Division of The Stanley Works, 690 Lake St., New Britain, Conn.

STANLEY

Circle 557 on page 19

If GEARS Are YOUR Problem

We Can...

- **act as your precision gear department**
- **keep your production line going smoothly without shut-downs**
- **reduce rejects, hand adjustments or other supervisory attention**
- **provide you with precise gearing for any purpose whatever**
- **and do it with a strict adherence to safe engineering economy**

SPECIALISTS IN THE FINE PITCH FIELD

Use our more than a decade of experience in Gear making, in any material, for America's most particular users of precision or commercial gears. Send blueprints or specs for prompt estimates to

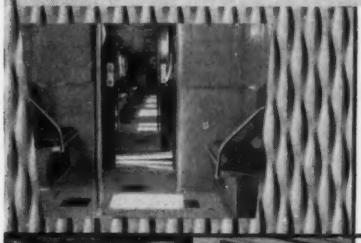
PROCESS GEAR CO., INC.

4608 W. Fullerton Ave. • Chicago 39, Illinois

Circle 558 on page 19

RIGID-tex METAL

demonstrates its Superiority ON THE RAILS



Wherever the going is rough, you'll find RIGID-tex Metal. Wainscoting and seat bases in this subway car are stainless RIGID-tex Metal pattern 5-WL.

Newest in rail transportation, the TALGO uses Stainless RIGID-tex Metal (Pattern 1-CS painted and hi-lited) for wainscoting. Takes kicks and scrapes yet remains new looking always.

See Sweet's Design File 1a/Ri or write for more information.

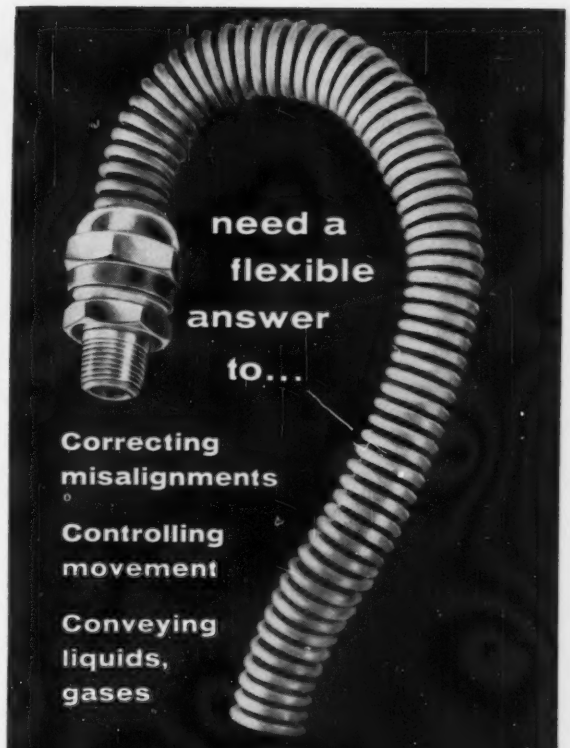
RIGID-tex METAL IT'S RIGIDIZED

RIGIDIZED METALS CORPORATION

69310 OHIO STREET BUFFALO 3, N. Y.

World-wide Distribution

Circle 559 on page 19



specify ATLANTIC METAL HOSE

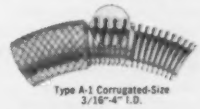
Atlantic flexible metal hose is JOB TESTED & CERTIFIED to withstand the most extreme conditions of temperature, pressure and rough usage. Wall thickness is absolutely uniform. Atlantic hose cannot kink, deteriorate or burst – and requires no maintenance.

Available in steel, bronze, monel and various alloys of stainless steel with proper fittings.

Write for Bulletin No. 500A. See our Catalog in Sweet's Product Design File. Specialized engineering consultation available.

Type BD-15 Convoluted-Size 3/16"-12" I.D.

Type BD-20 Convoluted-Size 3/16"-1½" I.D.



Type A-1 Corrugated-Size 3/16"-4" I.D.

Type SW Corrugated-Size 1"-20" I.D.

ATLANTIC METAL HOSE CO. INC.

318 Dyckman St., New York 34, N. Y.

push-pull CONTROLS

Compression & Tension Type

Aircraft cable is strung with spherical steel shells in a rigid or flexible housing sealed with "O" rings. 3" standard bend radius. ¾" minimum bend radius.

Three Types:

1. *Light Duty*—Compression Ult. Load 1250 lbs.; Ult. tension 960 lbs.
2. *Heavy Duty*—Compression Ult. Load 1650 lbs.; Ult. tension 960 lbs.
3. *Extra Heavy Duty*—Compression Ult. Load 3050 lbs.; Ult. tension 3900 lbs.

Positive remote controls for actuating mechanical, hydraulic or other devices. Eliminate bell cranks, pulleys and dual cables. Patented U. S. A. All world rights reserved. Send for ENGINEERING MANUAL giving detailed prints and complete specifications covering materials, finishes, capacities. Please address Dept. MD-57.

SOUTHWEST PRODUCTS CO.

1705 SO. MOUNTAIN AVE., MONROVIA, CALIFORNIA

Circle 560 on page 19

Circle 561 on page 19

ENGINEERS

AVAILABLE OR WANTED

AVAILABLE: Mechanical design engineer, experienced and competent, available for projects and limited engagements. Over twenty years of experience on drafting, design, development—production tools, power press dies, machinery, product. Any location. Address: Boxholder, 202 Back Bay Postal Annex, Boston, Massachusetts.

AVAILABLE: Established engineering sales agent in the Philadelphia area—Top quality representation in the Eastern Pennsylvania, South Jersey and Delaware areas. Interested in acquiring one or two additional well-rated equipment lines—mechanical or electrical—selling to original equipment manufacturers. Exclusive basis only. Write P.O. Box 2951, Philadelphia 26, Pennsylvania.

WANTED: Project Leader (Mechanical Engineer). This industrial research and consulting organization has an opening for a senior engineer who can take full responsibility for consulting assignments and who can help expand our services in manufacturing, process analysis, mechanization, product development, machine design, and related fields. Our assignments in this field range from preliminary appraisals to over-all systems engineering and prototype fabrication. Applicants should have 15 years' industrial experience, a keen interest in the technical problems of business and in the development of automatic production processes, facility for conducting client relationships on a professional basis, and competence at directing engineering development programs. Other desirable qualifications include: experience in selling consulting services, willingness to travel up to ¼ of time, and technical competence and business contacts in a specific area of industry such as food processing, plastics production, packaging machinery, electronic component manufacture, or the like. Send resume to Charles V. Schock, Arthur D. Little, Incorporated, 30 Memorial Drive, Cambridge 42, Massachusetts.

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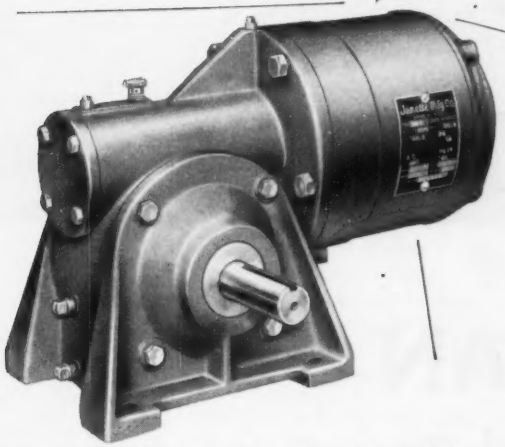
BPA NBP

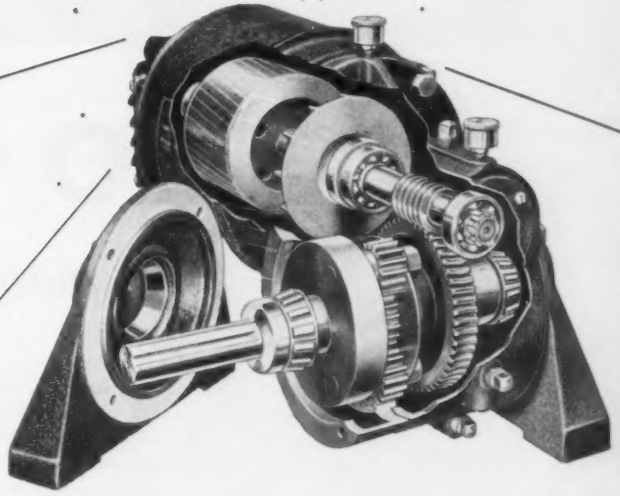
Advertising Index

One touch of genius . . .

by the design engineer

and . . .





Production lines hum—transportation and distribution move fast to keep up with the pace of sales.

ONE TOUCH OF GENIUS back in 1910 by a Janette engineer made it possible for all design engineers to have at all times the exact precise control of speed and power needed to give them the right speed — the right power — in one single machine — in a wide variety of models — in any horsepower from 1/150 to 7½ in any needed mounting position.

When your design includes Janette gear motors and speed reducers — the great factor of the right speed and the right power is achieved. Then you have the opportunity to design that ONE TOUCH OF GENIUS into your product which will lift that product above all competitors.

Write for Janette Bulletin 5-105 M-4. Get the complete Janette story.

REPRESENTATIVES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Circle 564 on page 19

Janette ELECTRIC MFG. CO.

MORTON GROVE, ILLINOIS

NOSCO "CAN DO"

takes mammoth projects in stride

Take the case of Gould-National Batteries, Inc. After personal inspection of many plastic molding plants, evaluating engineering personnel and facilities, Gould selected Nosco to produce a new line of ten stationary battery containers and their covers. Nosco "Can Do" started by assigning an experienced sales-engineer to supervise and coordinate the program and report progress to Gould every two weeks. Twenty molds were completed in little more time than is usually required to produce one . . . from drawing board through chrome plating. Nosco molded the containers of acrylonitrile, running several molds simultaneously on giant pre-plasticized presses. The molded pieces were annealed a truckload at a time, and decorated by an ingenious method which avoided duplication of screens. Finally, these parts received comprehensive approval by Western Electric inspectors.

The Gould-National contract is one more indication of the scope of Nosco "Can Do". More than service, engineering, and production know-how, Nosco "Can Do" includes the financial ability to carry large tooling and warehousing programs.

When awarding your large plastic parts program, call on Nosco "Can Do".

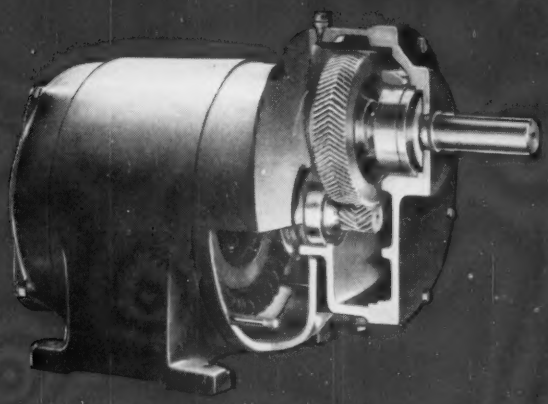
The first step is to write—

For other case histories—and for a glimpse of the Nosco plant and facilities, send for the free 12-page brochure, "How the Nosco Plant Works to Produce Your Needs in Practical Plastics."

NOSCO plastics, inc. • erie 2, pa.

World's largest injection molding plant

Circle 565 on page 19



SINGLE REDUCTION
Parallel Shaft Type

MASTER -1st Choice for GEARMOTORS

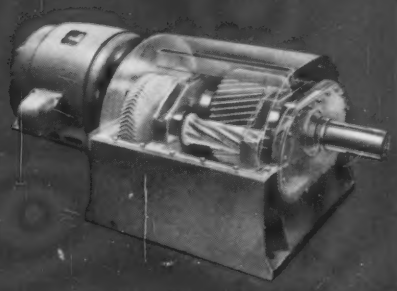
Because...

...With five types of parallel and right angle Gearmotors, Master has the flexibility and choice of design you need for selected output speeds.

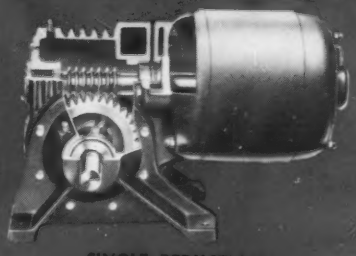
...With electric motor and gears combined into a compact, integral power unit, you reduce costs and increase efficiency through elimination of belts, couplings, chains, sprockets, external bearings or separate reducers.

...Available in sizes from 1/8 to 125 H.P. You can integrate with the gearmotor electric brakes—3 types of variable speed units and fluid drive in any combination.

...And that's why more gearmotors carry the Master name than all other makes combined. Write on your business letterhead for details.



DOUBLE REDUCTION
Parallel Shaft Type



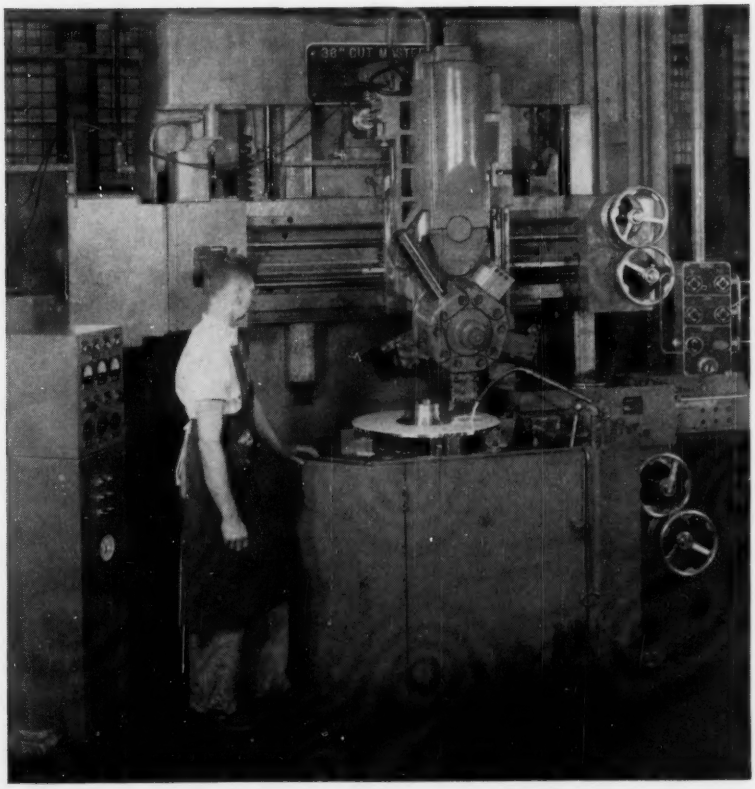
SINGLE REDUCTION
Right Angle Shaft Type

THE MASTER ELECTRIC COMPANY

Dayton 1, Ohio

Circle 402 on page 10

TIMKEN® bearing equipped . . . 1 lathe replaces 4, cuts machining time 81%

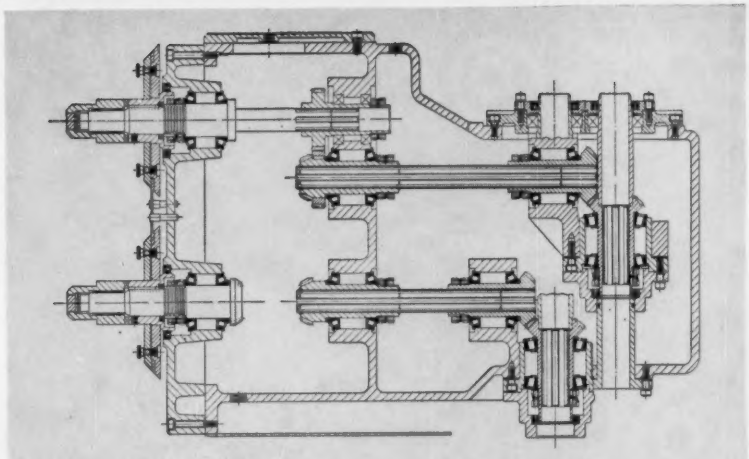


THIS new Bullard 36" Cut Master Vertical Turret Lathe, turning out hub discs and cover discs for turbo wheels at the York Corporation, York, Pa., has cut machining time an average of 81%. And does all the operations formerly done on 1 horizontal turret lathe, 2 engine lathes, and 1 older vertical turret lathe! Timken® tapered roller bearings play a major role in this production story.

16 Timken bearings in the hand wheel bracket—and other Timken bearings in the headstock and feed works—maintain precision, locate shafts and gears, hold integral parts in accurate alignment. Reduce wear.

Maintenance costs are low, with Timken bearings built to last the life of the lathe. Friction is practically eliminated, conserving power. Timken bearings are geometrically designed, precision-manufactured, to give *true rolling motion.* To insure highest quality, we even make our own fine alloy steel—which no other American bearing maker does.

Look for the trade-mark "Timken" on each bearing! The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".



How **THE BULLARD COMPANY** mounts 16 Timken tapered roller bearings in the Hand Wheel Brackets of their vertical turret lathes.

This symbol on a product means its bearings are the best.

TIMKEN *TAPERED ROLLER BEARINGS ROLL THE LOAD*

TRADE-MARK REG. U. S. PAT. OFF.

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